PROJECT PLANS AND RECORD-KEEPING ON CONSTRUCTION SITES IN THE UNITED KINGDOM

by

Stephen Scott, BSc, MSc, CEng MICE

NEWCASTLE UNIVERSITY LIBRARY

091 51649 2

Thesis L3959

A thesis submitted for the degree of Doctor of Philosophy in Engineering at the University of Newcastle-upon-Tyne,

Department of Civil Engineering

December 1991

CONTENTS

CHAPTER 7: OVERVIEW OF INFORMATION SYSTEMS

CHAPTER 8: RECORD-KEEPING ON CONSTRUCTION SITES

CHAPTER 9: RECORD-KEEPER, A COMPUTER PROGRAM FOR KEEPING RECORDS ON CONSTRUCTION SITES

CHAPTER 10: A NEW MODEL FOR TEACHING THE CRITICAL PATH METHOD

CHAPTER 11: THE MAIN FINDINGS

APPENDICES

ACKNOWLEDGEMENTS

The author wishes to express his sincere gratitude to his supervisor, Professor C.J.F.P. Jones of the Department of Civil Engineering, University of Newcastle upon Tyne for his support and guidance throughout the course of this work. Thanks are also due to the organisations and individuals within the construction industry who were willing to give of their time. Without that contribution a major part of this study would not have been possible.

SUMMARY

The main part of this thesis involves an investigation into the ways in which contractors and supervising engineers deal with the programme of works for their projects. A secondary strand concerns the problems of record-keeping, in particular the records needed to assess claims for delay. A final chapter is included to describe a new model for teaching the principles of CPM, which developed from the research.

Little is known about the procedures adopted for specifying project plans, for checking them or for using them to assess contractual claims. By interviewing contractors and consulting engineers using a questionnaire, this area has been opened up and information obtained to allow sensible recommendations to be made. The problems of concurrent delay have been examined and new ideas as to how they may be dealt with put forward. Some of the procedures used for this section of the work are considered to be novel and original.

In considering the problems of assessing delay claims, it soon became clear that an 'as-built' record of progress would be most helpful, and a computer program to generate such a record has been written. The author is not aware of any such similar program.

Finally, the model for teaching CPM is an innovation. It uses a recognized format, that of the time-scaled diagram, but adds another dimension in allowing the activities to move on the diagram within the logic of the network.

Throughout this thesis, the capitalized forms of engineer and contractor (Engineer and Contractor) have been given special meanings. Two separate questionnaires were used: one for the professionals involved in contract supervision and one for those involved in the construction of the contract. The particular interviewees questioned using the first of these questionnaires have been described as Engineers and those questioned using the second questionnaire as Contractors.

LIST OF FIGURES

CHAPTER 6 | | PAGE NO.

CHAPTER 7

No figures

CHAPTER 8

No figures

CHAPTER 9

CHAPTER 10

LIST OF TABLES

INTRODUCTION

The faded, yellowing chart on the main noticeboard as you enter a site office will almost certainly be the programme of works. This document, sent by the contractor to the resident engineer, is obviously thought to be of some considerable importance: hence its prestigious position. It is to be hoped that further copies of this chart exist in the contractor's and resident engineer's offices and that these copies are being consulted and kept up to date. The initial version of this plan, while it lays out the contractor's intended order of working will on most sites soon be overtaken by events. Dates and sequences will be affected by what actually happens, which will generally be other than what was anticipated.

The process of updating the programme is recognized as an essential stage in the control process. To compare actual progress on the site with the initial plan will almost always prove fruitless. However, if the plan has been updated to take account of current progress, then new and more achievable targets will have been set for the works. This procedure involving the use of programmes during construction is generally well understood and has been the subject of numerous technical papers. Other uses of the programme are also recognized, although these have been less well researched, especially in the U.K.. One such use of the programme is to quantify the effects of delays to the contract, and thus to permit the proper assessment of extension of time claims. Many writers have realized the difficulty of dealing with these claims, but in the U.K. literature the mechanism of using programmes for this purpose seems not to be well understood. In contrast, this area has been developed to a much greater degree in the U.S.A..

These programmes, required on every contract, could be provided in one of a number of different formats and will typically be checked by a member of the engineer's staff. Very little has been written concerning either the format which should be adopted or the way in which these programmes should be checked. One of the principal aims of the research carried out for this thesis is to gain a good understanding of the various ways in which programmes may be used, so that sound advice on these matters may be given.

As a means of identifying the current practice in the industry, a questionnaire was developed, and a number of contractors and engineers were interviewed using the questionnaire as a basis. When generating the questions to be included in the questionnaire it was necessary to try to ensure that the most important areas were covered. This was achieved by spending time at the beginning of the study in regular visits to a major construction site. On these visits, the programme for the site in question was studied in some detail. The opportunity was also taken to tour the site each time to make a record of the progress of the works. It had become clear by that time, that an 'as-built' record in terms of the activities on the contractor's programme would probably be very important for making judgements on the contractor's rights to extensions of time. From this experience, the idea to write a computer program for keeping such a record arose, which became a separate, though related part of the research work. Thus, the thesis developed into two main themes: the use of programmes, reported in chapters 1 - 6 and record-keeping, leading to the development of a new piece of software in chapters 7 - 9. A further chapter, chapter 10, has been added to describe a teaching tool which developed from the author's interests in this area. Chapter 11 reviews the findings of the thesis as a whole.

In the first section, chapters 1 and 2 discuss the use of programmes recorded in the literature in the U.K. and outside the U.K., respectively. As previously mentioned, a considerable gulf appears to exist in the way in which these matters are understood within the U.K., particularly when compared to the U.S.A.. Chapter 3 then considers the special problem of concurrent delays. Three different methods of dealing with such delays are identified and critically examined. With a greater insight into the nature of delays generated from the current study, it is felt that a better appreciation of this whole problem has resulted. Chapter 4 describes the development of the questionnaire and chapters 5 and 6 deal with a discussion of the results and the recommendations and conclusions stemming from this work. The method used to develop the questions used in the questionnaire was certainly new to the author, and the system of using simplified claims scenarios to identify the respondent's attitudes has not been seen elsewhere. Surveys of CPM use in the industry have been carried out before, but these have never concentrated on procedures used during construction in the way that the present research has done.

In the second section of the thesis, chapter 7 reviews the literature concerning record-keeping in general in an attempt to understand the problems which have been found with such systems. The following chapter, chapter 8 then considers the particular problems of record-keeping on construction sites and analyses the questions on the questionnaire aimed at this area. It is chapter 9 in which the new software is described. No other piece of software for carrying out this activity has been identified, and yet the program is thought to have quite a wide application.

Chapter 10 describes a new tool for teaching the basic principles of CPM which can be described as a dynamic time-scaled model. It portrays a simple CPM, drawn time-scaled, but in which the various activities are able to move within the restricted logic of the network. The idea to produce such a diagram undoubtedly stemmed from the author's research in this area, and is thus felt to be a proper part of this work. No similar models have been seen, although the time-scaled CPM is clearly well recognized. As previously stated, chapter 11 sums up the findings of the thesis as a whole.

CHAPTER 1

USE OF CONTRACT PROGRAMMES IN THE UNITED KINGDOM

The starting point for our understanding of this topic must be to review the Conditions of Contract and Forms of Tender, Agreement and Bond for use in connection with Works of Civil Engineering Construction 5th edition (1). This is the contract form most likely to be used for civil engineering works in the U.K. (hereafter called ICE5). There is no need to analyse the whole of this form, as this has already been competently carried out by such writers as Abrahamson (2) and Wallace (3). The aim must be to identify all clauses that have some impact on the use of programmes and to review them only. Following this, the rest of the chapter will enlarge on the interpretation of such clauses found in the literature on this and other U.K. contract forms.

Provision of a Programme: Clause 14, ICE5

The only clause in the whole of ICE5 that refers specifically to a programme is clause 14. In this clause, the contractor is required to submit to the engineer for his approval,'...a programme showing the order of procedure in which he proposes to carry out the Works.....' No other information about the form of the programme beyond this statement is given. Of course, the engineer can amend this clause or include a clause in the specification, if he so wishes, to require a particular format for the programme. If no such amendment is made then the type of programme submitted is left to the contractor's discretion.

Subsections of this clause entitle the engineer to a revised programme if, during the carrying out of the Works, actual progress does not conform with the approved programme. It is also stated that the contractor is not relieved of any of his duties or obligations under the contract as a result of the engineer's approval of his programme.

The use of the phrase 'contract programme', it should be stressed, is not intended to link this programme, which the contractor is obliged to provide, with the contract documents. These have a particular significance in that they define the agreement between contractor and employer. As Abrahamson (2) says:

> 'The programme....is not contractual in the same sense as the specification, since neither the contractor nor the employer is bound by it. The programme is what it is - a document indicating the intention of the contractor at the time he furnishes it as to how he intends to programme the works......'

The phrase then, is simply used to signify,' that programme which the contractor is required to produce and which in ICE5 might be called the clause 14 programme.'

As previously disclosed, the programme does not get any further mention in the whole of the contract form. This is true even though there are areas covered in the form in which use of the programme may well be the best or only way to proceed. It is these clauses, most likely to require the use of the programme to permit them to be brought into effect, or that have some bearing on contract time that will be considered next.

Delays, progress and contract time in ICE5

A number of clauses exist that, given the right circumstances, permit the contractor to claim for an extension of the contract time together with associated costs attributable to the delay. These clauses are as follows:

Clause No	*Description of type of delay covered*
Cl 7	Delay in issuing further drawings or instructions;
Cl 12	Delay due to unforeseen adverse physical conditions or artificial obstructions;
Cl 13	Delay due to engineer's instructions to explain or adjust the Contract;

Cl 14 Delay due to late consent to methods of construction;

Cl 27 Delay due to variations in areas of PUSWA (Public Utilities and Street Works Act) works;

Cl 31 Delay due to affording facilities to other contractors;

Cl 40 Delay due to suspension of the Works not previously advised;

Cl 42 Delay due to failure to give possession of all or part of the site;

Cl 59B Delay due to forfeiture of a nominated subcontract

The wording in each of these clauses varies a little, but generally states that the engineer shall take such delay into account in determining any extension of time to which the contractor is entitled under clause 44. There is also a statement that the contractor should subject to clause 52(4) be paid such cost as may be reasonable.

Clause 44 itself, refers generally to the above delay clauses and also adds that any delays resulting from variations (Cl 51(1)), increased quantities (Cl 51(3)), exceptional adverse weather or other special circumstances should be considered if they fairly entitle the contractor to an extension of time. Such possible extensions of time, if requested by the contractor or thought fit by the engineer, are to be considered on an interim basis, at the due date for completion and where relevant at the extended date for completion. No guidance is given about how this is to be done. The clause simply says that the engineer should,'....consider all the circumstances known to him at the time and make an assessment of the extension of time (if any) to which he considers the contractor entitled....' An important point to notice is that clause 44 is merely concerned with considerations of possible extensions of time, and not with costs. Any attempt by a contractor to recover additional overhead costs for an extended period must be founded on a claim justified by a clause other than clause 44.

The time window in which the contract must be performed initially is specified in clauses 41 and 43. Clause 41 deals with the date for commencement of the Works, notified to the contractor by the engineer, while clause 43 points to the Appendix to the Form of Tender where the original time for completion is to be found. In reality completion of the Works is not necessarily an easy stage to define. Clause 48 is included to lay out a procedure whereby the contractor may claim to have substantially completed the

Works and the engineer has the opportunity to consider that claim. If accepted, the certificate of completion will be issued and the period of maintenance begins at that point.

Two further clauses must be considered before leaving this section: clause 46 dealing with rate of progress and clause 47 which relates to liquidated damages. Clause 46 gives the engineer, where he believes that the contractor's rate of progress is too slow, the right to request that the contractor,'..expedite progress so as to complete the Works....by the prescribed time or extended time.' This is a formal notification from the engineer that will typically only be given when he is sure (presumably having used the programme to ascertain this) that at the current rate of progress the project will not be completed on time. Of course, in many instances delays to a project will result in damages being suffered by the employer. This will be either in terms of lost profit from being unable to use the project, or in lost benefits to the community who would gain by the existence of the project. These possible losses are quantified in the contract documents as liquidated damages recoverable from the contractor for delays in handing over the finished job. It is clause 47 that defines how these damages may be recovered.

Much more could be said about these clauses, but the aim here is simply to create the starting point for the rest of the thesis and to ensure that the basic facts are understood. However, because understanding of these matters is so vital to the following work, a diagram (figure 1.1) has been included to aid clarification.

Having briefly dealt with the relevant clauses in ICE5, the next stage will be to look at the problems associated with implementing these conditions. Later sections of this chapter will deal with some of the more specific issues.

General comments and interpretations

Much of what has been written in this area relates to the problems of assessing a contractor's claim for an extension of time and associated damages. It is clear that these difficulties have often no easy solution and that a common response from contractors is to make their claims based on the actual costs to them of carrying out the contract. Both Abrahamson (2) and Goodacre (4) recognize this tendency and warn against it. This *quantum meruit* approach in which the original contract is disregarded on the grounds that the Works were disrupted by the employer is seen to be generally unacceptable in most circumstances. To claim costs for disruption and delay, the contractor is expected to identify the delaying events and prove that it is these events that have caused delays to the contract as a whole; not any matters for which the contractor is responsible. As we shall see later, however, little guidance is given about how best to do this.

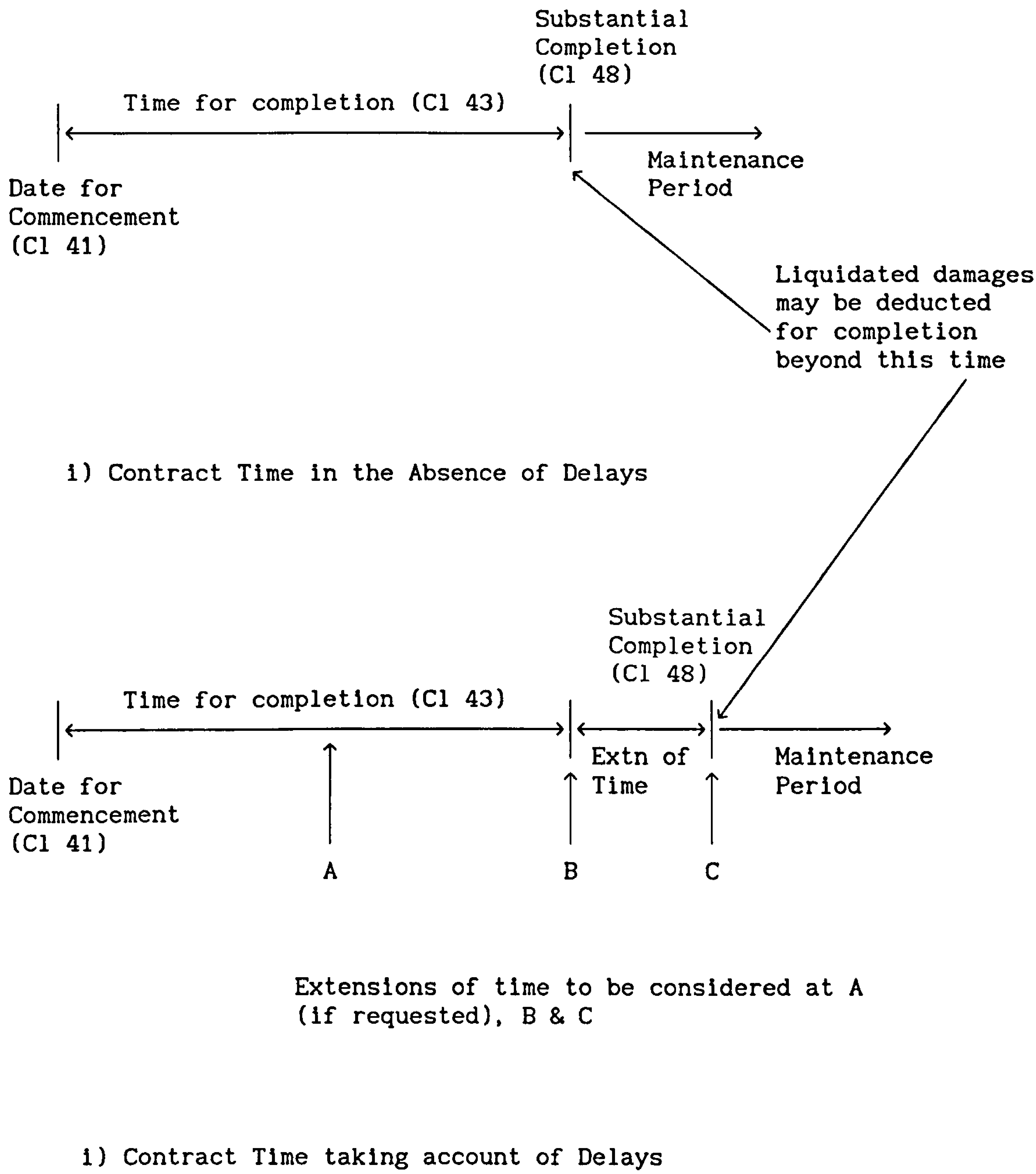


Figure 1.1 Definition of Contract Time in ICE5

This difficulty in untangling the costs rightly payable to the contractor from those that he caused himself is also evidenced by Worby et al (5) in an article concerned with the management of claims by the construction industry. In discussing the late settlement of claims, he states that: 'Both clients and contractors said that final negotiations tended to be commercial rather than technical with all outstanding claims gathered together into a global settlement.' The suggestion here then, is that in the absence of any accepted method for unravelling these matters, a practical approach is adopted and a commercial settlement agreed. Also in the same article, it was said that the majority of respondents (to the interviews held) thought that relationships, especially those on site, were very important to the management of claims. Again, another indicator that these problems may be dealt with in a less than scientific manner.

The initial evidence then would suggest that there is little common ground on an overall approach to such matters even though the importance of overcoming such difficulties is well accepted. Abrahamson (2) says, when discussing this issue:

> 'It is grossly unfair both to employers and contractors that the mechanism to determine the actual full costs of disruption to a contractor, and to divide them from the costs due to his own inefficiency is lacking more often than not.'

The possibility that there may be no consensus on a generalized procedure, however, does not mean that there is nothing else that has been written on the subject. A number of scenarios depicting possible outcomes to contracts have been discussed in the literature and recommendations offered on how they should be dealt with. The aim would seem to be to try to consolidate those aspects that can be agreed upon so that the areas for disagreement are diminished. One such scenario is described by Hughes (6) and involves a contractor on a contract for which the time for completion is 2 years. He says that it is not correct to argue that the contractor should have allowed for 2 years worth of overheads if his actual programme showed him completing in 18 months. Thus any delays that cause the contractor to have to remain on site longer than this time (18 months), if they can be proved to be the employer's responsibility, should allow the contractor to recover his properly incurred damages in accordance with the contract. These statements are made by Hughes in relation to a contract governed by JCT conditions (7), but are effectively backed up by Abrahamson (2) when discussing ICE5. Abrahamson bases this view on the fact that the time for completion is the maximum time, there being no minimum time and the contractor being free to complete as early as he can. Unfortunately, there are some writers who disagree with this analysis. The most up to date statement denying this is found in Powell-Smith and Stephenson (8). They cite the court case Glenlion

Construction v The Guinness Trust (1987), to state that a contractor will not have a claim for delay unless his completion is delayed until after the contractual time for completion has expired. This, specifically, when the contractor's clause 14 programme shows completion before the time specified in the contract. It might be thought that it was this new legal precedent, only recently set, that has brought about a different appreciation of such cases, but this is not necessarily correct. Indeed, the view expressed by Powell-Smith and Stephenson, is also held by Audas (9), Trickey (10) and Marks et al (11), writing as early as 1978.

Other scenarios that are analysed involve overlapping or 'concurrent' delays that are the responsibility of different parties and thus would, occurring alone, give different rights to extensions of time with or without recovery of overheads. The various ways in which these situations have been dealt with in the literature will be covered in a later chapter and so will not be considered further here. Suffice to say that in this area also, there is little in the way of consensus.

Certain matters have been considered and decided by the courts in this area, although they tend to be far from the far-reaching decisions that we might wish to see. Examples of such judgements are:

Peak Construction (Liverpool) Ltd. v *McKinney Foundations Ltd* (1979)

In which the liquidated damages quoted for a contract were said not to be applicable when failure to complete on time was due to the fault of both the contractor and the employer. The employer must recover such damages as he can prove flow from the contractor's breach.

Yorkshire Water Authority v *McAlpine and Son* (1985)

The employer, YWA, expressly incorporated a method statement into the contract and thereby gave the contractor, McAlpine, the right to rely on these details. It was no longer the contractor's responsibility to make revisions to the method of working when these details turned out to be impossible to construct.

Stanley Hugh Leach v *The London Borough of Merton* (1985)

In this case, it was accepted that a contractor's programme that indicated the dates on which drawings and other information were required from the architect was acceptable as the notice required by the contract.

There is, of course, always the opportunity for a contractor to take a claim for breach of contract to court, and it is clear that this is the only avenue open to the contractor when the claim is extra-contractual. Such claims for breach, according to Powell-Smith and Stephenson (8), usually relate to implied terms in the contract that the employer will co-operate with the contractor to ensure the successful completion of the contract. In general terms for all claims, the maxim that,'..he who asserts must prove,' will be considered to hold and the standard of proof required is ,'..on the balance of probabilities.' That is, that the evidence supporting a claim must be weightier than that against it if it is to succeed. This is the approach we should expect from a civil court, but whether the engineers making judgements on these matters see them in this light, when claims are contractual, is clearly not certain.

Recommended form of the Contract Programme

While the literature reviewed does not abound with specific recommendations or exhortations to contractors or consultants as to the best format for a contract programme, there is still some material which it is considered fits fairly comfortably under this heading. This tends to consist of views on the general use of contract programmes during construction, surveys of practice in the industry and general comments on specific advantages and disadvantages of the CPM method. The possible options for the format of the contract programme are likely to be:

i)	Bar chart	(figure 1.2)
ii)	CPM network	(figure 1.3)
iii)	Linked bar chart	(figure 1.4)
iv)	Time-scaled CPM diagram	(figure 1.5)
v)	Time-distance diagram	(figure 1.6)
vi)	Some combination of the above	

.....and yet, it is the bar chart, the CPM network or some combination of these two that would appear to be exclusively considered in the literature.

To begin with general views on the use of contract programmes, it appears that there is some uncertainty amongst those having to use them, as to quite how this should be done. With regard to updating of the programme, Arditi (12) found that site managers tended to be confused as to what updating meant, what it achieved and were disillusioned when their programmes had to be updated frequently. This may well have lead to them recommending that one of the factors that would be likely to promote success in the use of CPM was to update networks as little as possible and to keep the logical sequence fixed. This view, of course, is completely at odds with what might be considered to be recommended practice in this area. Regular updating of a network is normally seen to be

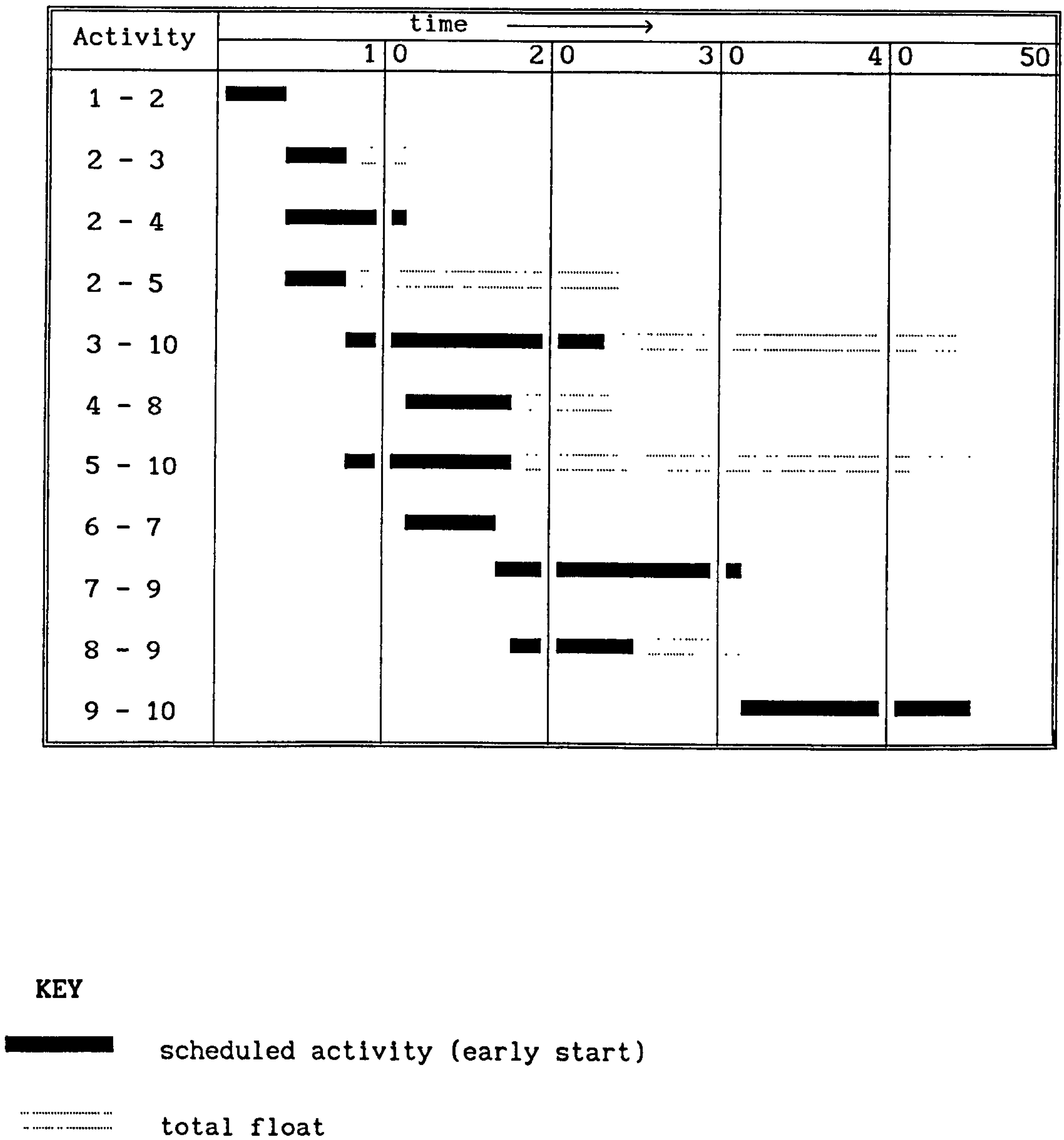


Figure 1.2 Bar chart

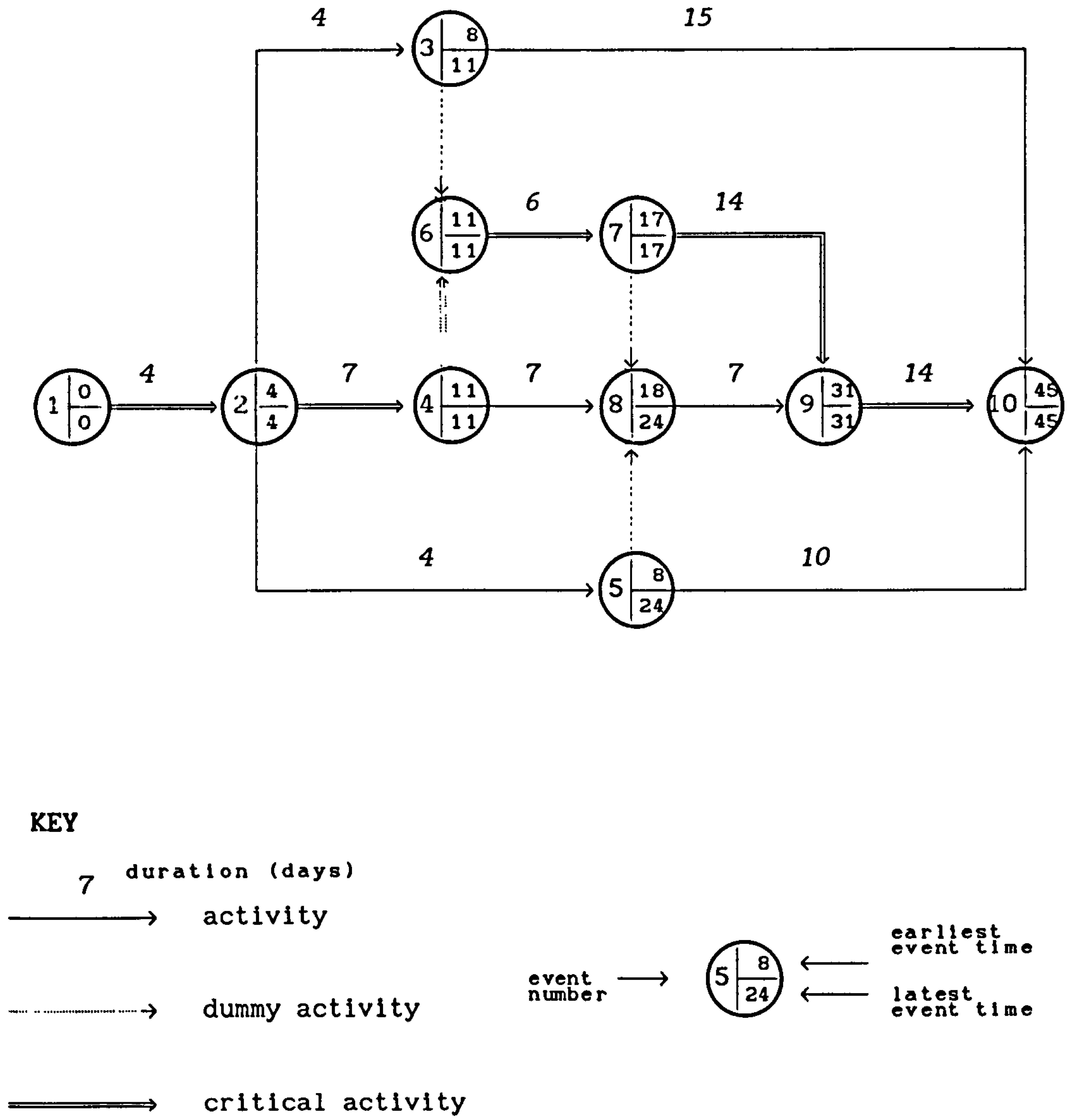
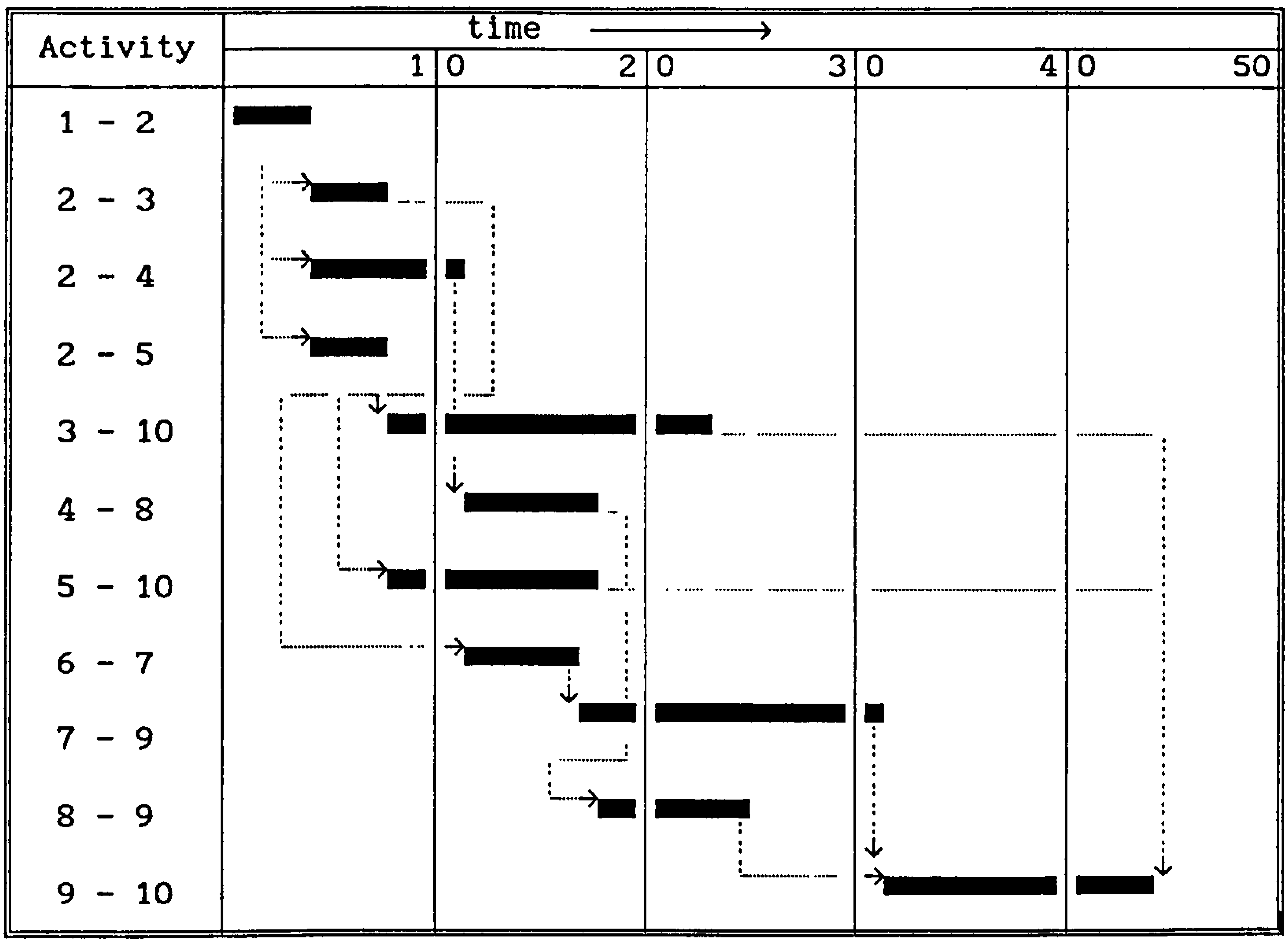


Figure 1.3 CPM network diagram



<u>KEY</u>

scheduled activity (early start)

links between activities .

Figure 1.4 Linked bar chart

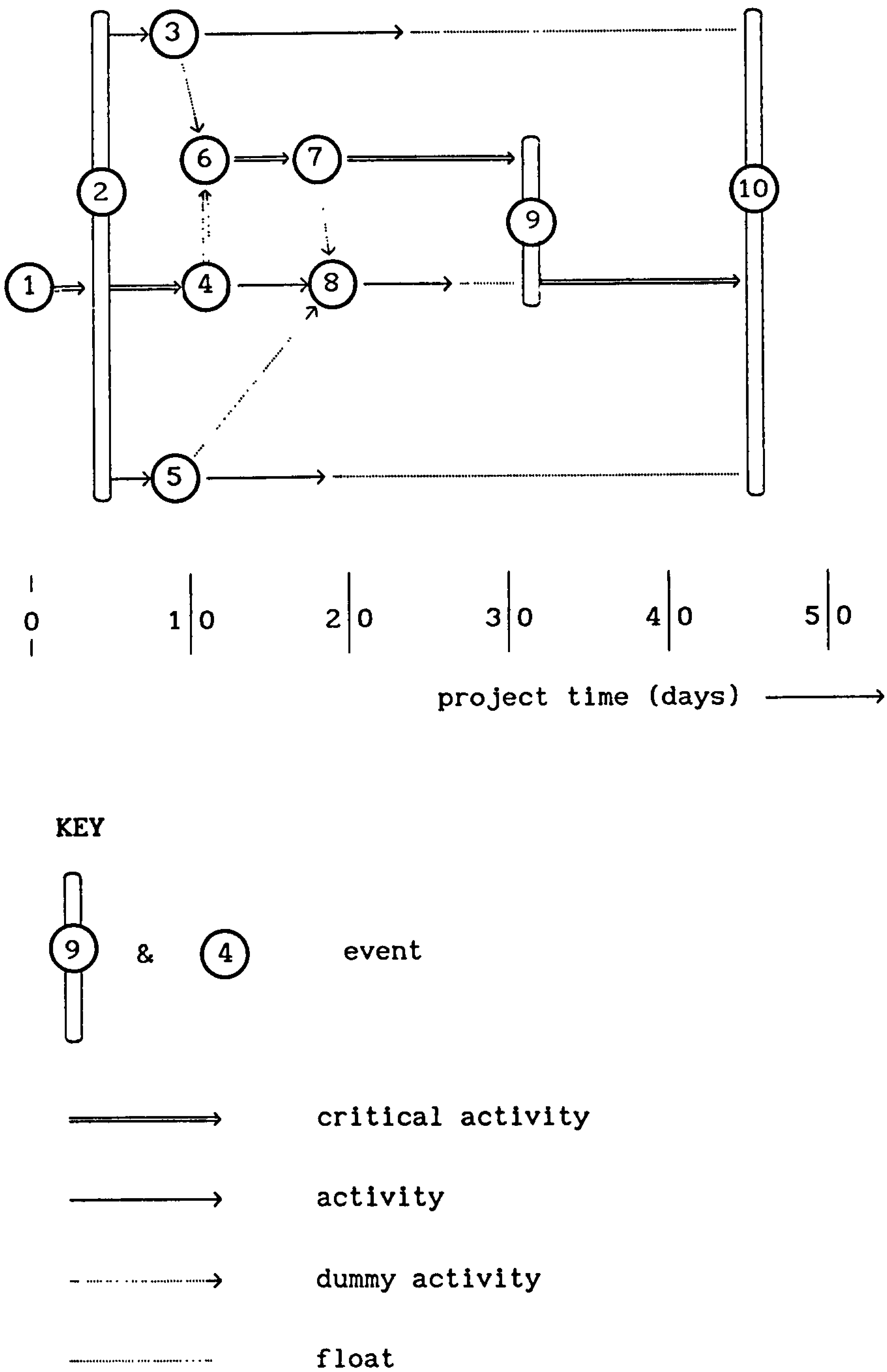
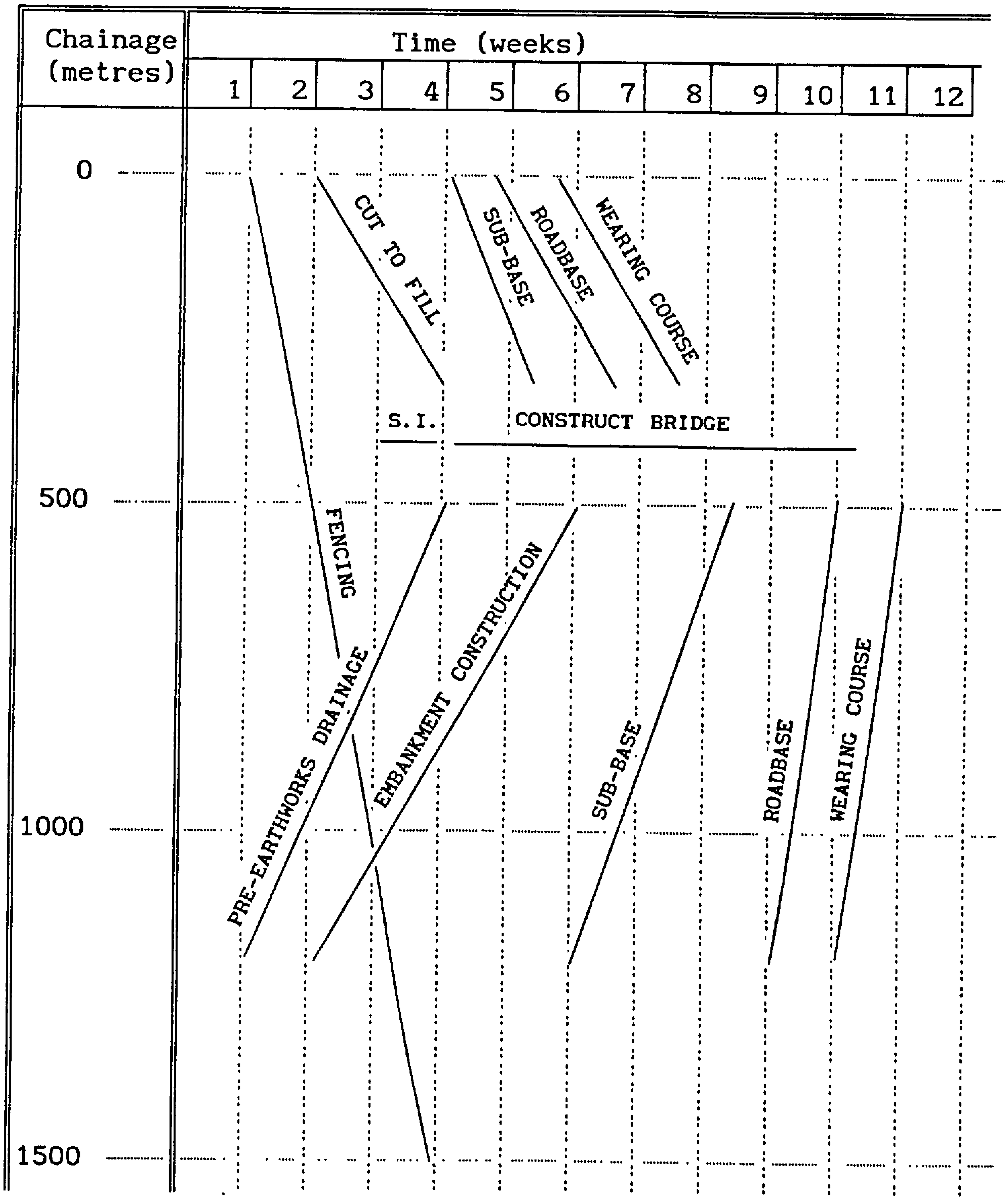
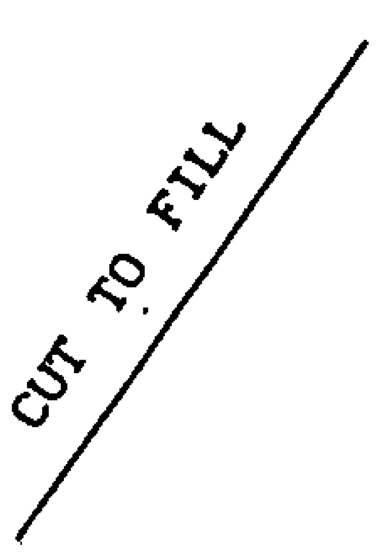


Figure 1.5 Time-scaled CPM diagram



KEY



activity

Figure 1.6 Time/distance diagram

essential to allow proper control to be exercised. Coupled with this uncertainty, Hughes (6) believes there to be some doubt, on the part of architects and engineers on the one hand and contractors on the other, as to the validity or purpose of such programmes. He reports that there is, or there is felt to be, an element of gamesmanship both in preparing them and in commenting on them.

In order to show the scheduled dates for activities making up a project, it might be thought that the bar chart is the ideal method of presentation. However, with a contract programme in this form, there is no detailed understanding of the interdependence of the various activities. This leads on to the suggestion that the combination of a bar chart as the main means of presenting the contract programme backed up with details of the network from which the bar chart was prepared might be the best solution. Such a combination is considered by Hale in the discussion (13) of a paper by Wade (14). Hale believes this approach to be unwise and to give no advantage over the use of networks alone if the basic planning has been done by network. An interesting and relevant point on this subject is made by Forinton (15) who states his belief that a good bar chart programme can usually be converted into a critical path programme if the method of construction is known. Surely though, we rely on the contract programme to indicate the method of construction as one of its main functions!

The critical path network as a means of representing the contractor's intentions concerning construction sequences and possible subsequent use for control and claims analysis also has its detractors. The following are the principal areas for concern:

i) The critical path method, which gives the impression that all projects can be represented by a network of activities where each activity depends on the completion of its predecessor(s) can be misleading. In practice, there is often the opportunity for considerable overlap to occur with some activities. This is noted by Woodward (16) and by Hancock (17).

ii) The concept of float within the CPM methodology is questionned by White (18). He points to the fact that following resource scheduling to produce a practical schedule for activities, it is possible that all float will disappear. In such a case all activities may be considered to be critical and any additional work instructed by the engineer would then give rise to a valid claim for an extension of time. On this basis, he queries whether CPM is an appropriate method of determining time extensions. In similar vein, Fondahl (19) comments that a contractor's CPM must have been submitted having considered resource considerations, otherwise any float shown may be fictional.

iii) Where float is evident in a contractor's programme, the controversy as to who should have the use of that float has been a source of a good deal of discussion. Forinton (15) is quite clear that the contractor should be entitled to the benefit of the float in his own programme. On the other hand Fondahl (19) recognizes that the employer should be able to make use of such float without incurring claims for project delays where the contractor has no need of it.

On the positive side, Hale (13), Marks et al (11) and Morris (20) all refer to the use of CPM when dealing with claims for extensions of time. Arditi (12), also reports that planners consider CPM to be the best method of controlling job progress.

If we wish to make recommendations about the best format to be adopted for contract programmes, it would clearly be foolish to ignore the current practice in the industry where that can be established. Three U.K. surveys are reported in the literature: one conducted by Wade (14) in 1968; one by Arditi in 1973 and one by Esthete and Langford (21) reported in 1987. With the increased availability of CPM software for use on microcomputers, any information about the format adopted in the earlier two surveys may clearly be questionable. However, as these surveys are the only known source of information prior to the current work, their results will be recorded here.

Wade's survey, attempting to assess the extent and mode of use of CPM by the industry, found that consultants tended to leave the format of the contract programme to the contractor, although it was stated that in future CPM would be specified. Contractors said that they presented their 'results' on site in bar chart form, showing the critical path and floats; these schedules being prepared from an initial CPM. Although percentages are quoted defining the proportions of those questionned adopting the various formats, it is not clear whether these formats are used simply for planning or as the format for the specific contract programme. For this reason they have not been included here.

The work carried out by Arditi was aimed at testing hypotheses on behavioural and technical factors affecting success in the use of network analysis. It was thus not specifically aimed at providing information on particular formats. Nevertheless, from the surveys he carried out it is clear that networks and bar charts were the main methods of presenting results.

The survey conducted by Esthete & Langford approached a broad band of companies in the construction industry, with only 13% of returns from specialist civil engineering firms, 34% from general builders and 53% from general building and civil engineering firms. For the planning of new work, contractors are reported as using either bar charts, or networks with bar charts in the majority of cases. Networks alone were found to be used on a very small percentage of projects. Having said this, those firms using networks pointed out that these were adopted for logic analysis and bar charts derived from these networks for site presentation. No attempt was made to approach consultants to find out what programme format they specified.

It is considered important before leaving this section to point to the fact that in practice, the possibility of more detailed sub-programmes being produced during construction to amplify the original contract programme cannot be overlooked. Indeed some tendering procedures will demand that contractors submit preliminary programmes with their tender.

Recommendations for checking the Contract Programme

The practice of the engineer checking and commenting on the contract programme in order to assess its suitability for approval must surely be carried out on each ICE5 contract that is let. Despite this fact, very little has been written on how this might best be done and indeed, only one U.K. source has been uncovered that addresses this problem specifically. Even an unpublished report produced by a local authority especially to guide contract supervisory staff has nothing particular to add on the matter.

It is Hughes (6) who makes a contribution to this area. He considers that the first priority is to check the technical requirements of the job. 'Has the appropriate time been allowed for striking formwork, are the sequences correct, has proper allowance been made for weather-susceptible operations etc.?' These, he says, if not correct must clearly be amended but otherwise comment must be more in terms of opinion rather than simple acceptance or rejection. The rest of his comments refer to the possibility that activities might have been underestimated in terms of their duration. This may have been done on purpose with the intention of establishing grounds for future claims, and he suggests that such a ploy may be countered by asking for details of the resources that the contractor intends to provide. Expressing an opinion that the times shown appear optimistic is suggested as a possible general comment on the programme as a whole.

While no other set of recommendations for a total checking procedure have been found, general comments that are relevant are made by Abrahamson (2), Wallace (3) and Walton (22). Abrahamson interprets clause 14 of ICE5 as meaning that the contract programme must indicate both sequence and durations of activities - this is also the interpretation of Powell-Smith & Stephenson (8). He also makes the point that the engineer should refuse to accept a programme if it is unrealistic. In similar vein, Wallace confirms that engineers should not hesitate to document any doubts re the feasibility of the programme submitted by the contractor. This, he says, is because an approved programme will lend some evidentiary support to claims for delay.

The comments made by Walton are not aimed specifically at contract programmes, but rather at CPM programmes in general. They do, however, have some relevance to the matter at hand. Walton is concerned with the optimum level of detail to be shown in programmes and makes the following points:

i) There is a need to keep the number of activities to a minimum to reduce complexity while ensuring that sufficient detail is provided to represent the project properly.

ii) In order to allocate responsibility for progress of activities, separate activities should be provided where a change in responsibility occurs.

iii) Wherever resources or resource levels are known to change, this will indicate the need for a new activity.

To conclude this section, a view from outside the industry of an operations research and sociological approach to the problems of the construction industry conducted by the Tavistock Institute (23) states that:

> 'At, or about, the time of contract, a programme is required of the builder. This programme will be

produced and agreed. But such agreement cannot be undertaken at this stage except by a collusion in acceptance of unreality by all parties. It is not possible to put exact dates to specified phases of the project at this time. The future holds too much uncertainty.'

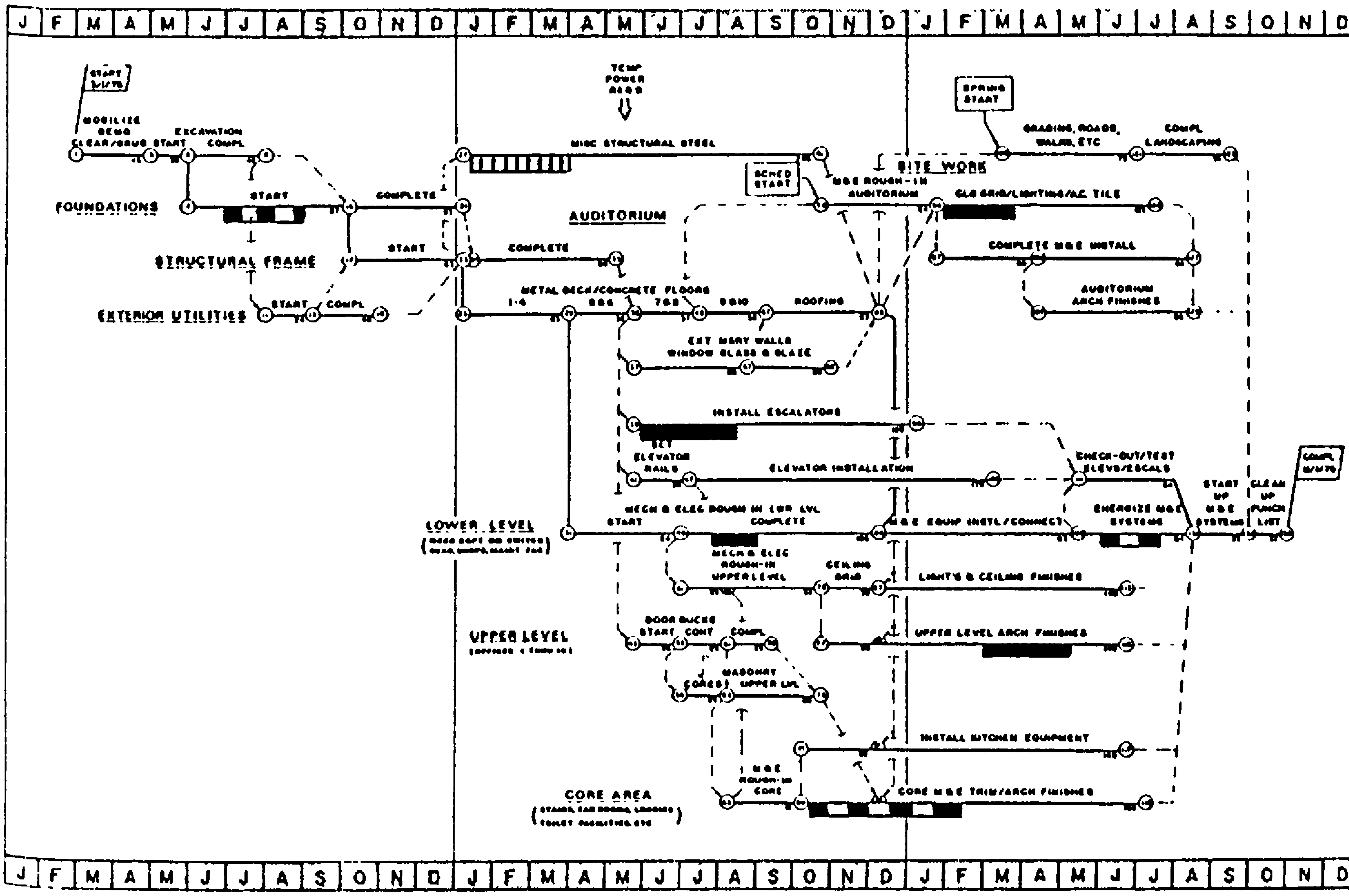
Methods of dealing with Delay Claims

On a reasonably complex project we may well expect that a number of delays will occur during construction. Some of these delays will be the responsibility of the employer (E), some the responsibility of the contractor (C) and others will be due to neither party (N): acts of God. If any of these delays were to exist alone on a contract and could be proved to have caused a delay to the project as a whole, then the contractual rights to additional time and costs would be:

Delay type	*Award*
E	Extension of time + extended overhead costs
C	No compensation
N	Extension of time without extended overhead costs

This interpretation of contract conditions is quite common and although this section is intended to be dealing only with U.K. matters, a similar interpretation has been reported in both Australia and the U.S.A.. Clearly, it is dangerous to generalize on contractual matters and for any particular contract, it is the actual conditions used that must be consulted. For example, the right to an extension of time under ICE5 for type N delays other than exceptional adverse weather (which is specifically covered) may be dependent on the engineer's interpretation. This aside, it should usually be possible to identify delays on any contract as falling into one of these three categories. The problem, however, is compounded by the fact that a number of examples of all three types of delay will have occurred in different parts of the project and at different times. Figure 1.7 is an attempt to give an indication of the complexity that might result. The difficulty is how to unravel this situation in order to recommend a just solution for both parties. Perhaps even more problematic is the fact that requests to consider extensions of time will have to be considered before the project is complete.

Much has been written about the problems of dealing with such claims but in the U.K. literature there is little by way of an attempt to identify a common approach. A number of writers either avoid the issue or suggest that use of critical path methods will aid the solution, before moving on to explain how overhead costs may be calculated. For example:



KEY

type E delay (EMPLOYER RESPONSIBLE)

type C delay (CONTRACTOR RESPONSIBLE)

type N delay (NEITHER PARTY RESPONSIBLE)

Original network from Discussion paper, ASCE Journal of the Construction Division, 1982, pp 357-359

Figure 1.7 Complexity of Delay Claims

> 'The majority of claim situations in the construction industry arise as a result of contract delays. Once delay factors have been dealt with and recognized by extensions of the contract period where appropriate, evaluation becomes largely a matter of dealing with time-based costs.' Major & Ranson (24)

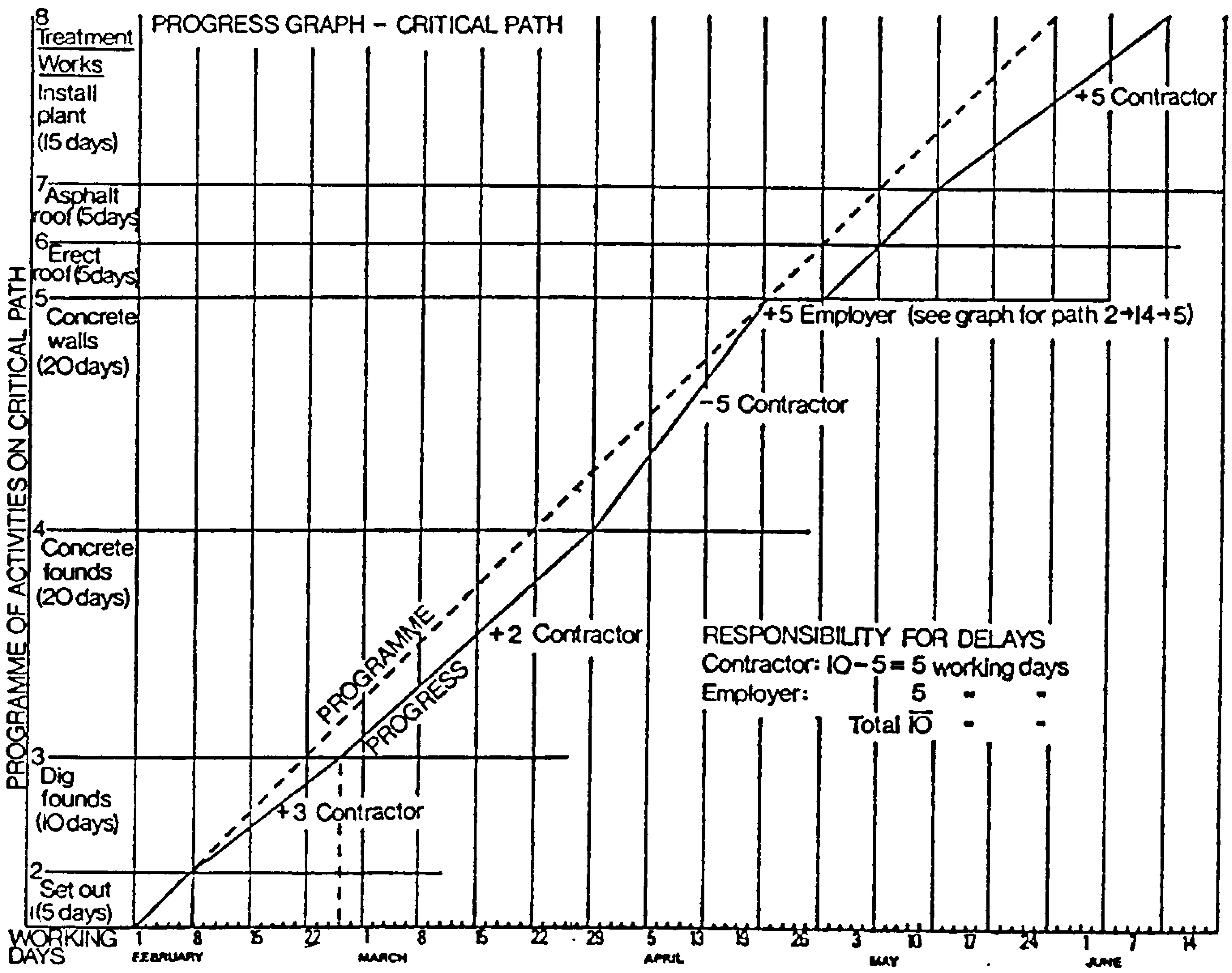
....and:

> 'The equitable settlement of these contractual claims has always been very difficult, but the application of the critical path method to the problem makes for a much fairer solution.' Marks et al (11)

In neither of the books from which these quotations are taken does analysis of the mechanism for justification of extensions of time get any greater consideration than this.

Some writers do go further and include an example of a delay situation represented either by a bar chart or a linked bar chart and attempt to show the problems of coping with parallel network paths. Goodacre (4) and Trickey (10) fall into this category but the examples given are very simplistic and tend merely to show a series of activities being shunted along by the offending delays. From this we understand that delays cannot simply be added arithmetically when they affect activities in different network paths but little else is added by this approach.

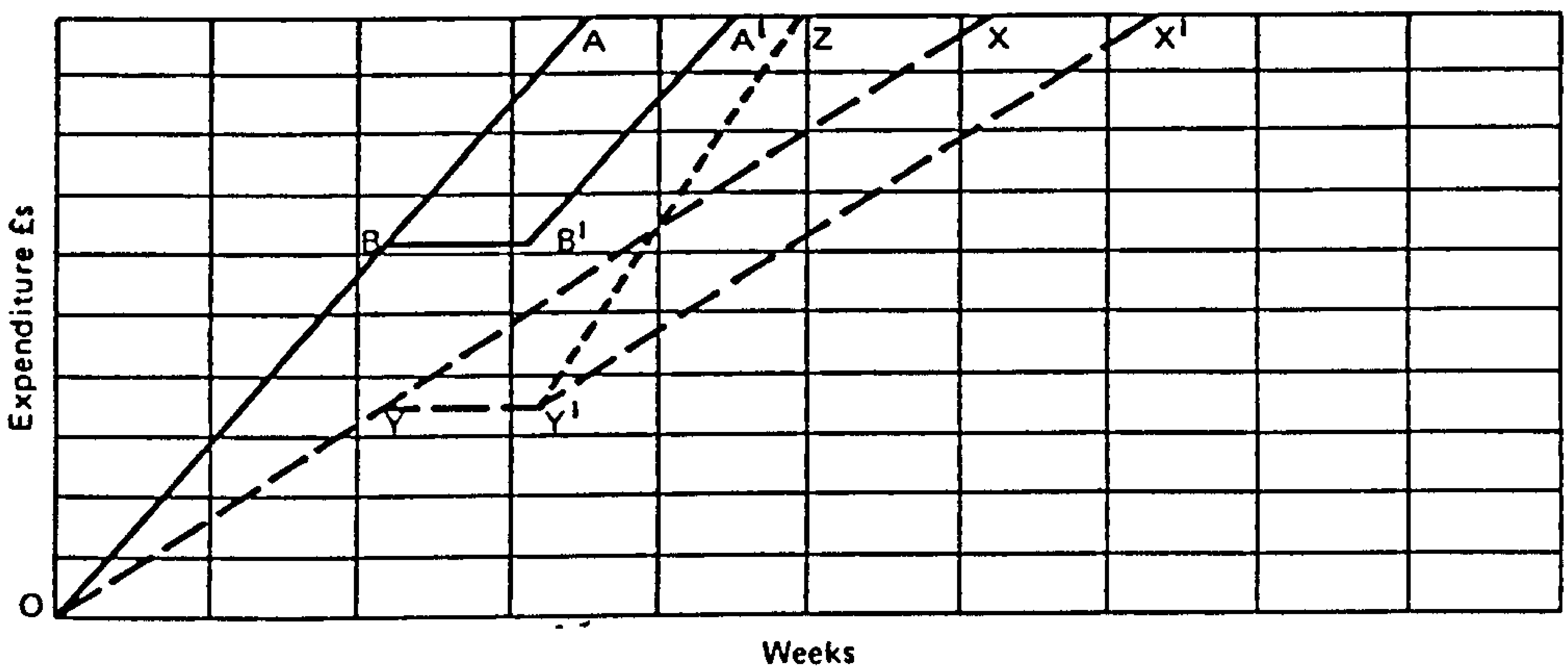
Forinton (15) suggests a graphical method of analysing these problems as shown in figure 1.8. He proposes that a progress chart be drawn indicating programmed periods for critical activities on the y-axis and with the x-axis



The above graph shows progress on the critical path. Other graphs are to be drawn where progress on sub-critical paths affects the progress on the critical path. In this example, a progress graph for path 2-14-5 had to be drawn to identify the cause of delay prior to erecting the roof.

Figure 1.8 Graphical Approach suggested by Forinton (15) marked with the working days. If the starts and ends of critical activities are then plotted and joined with a straight line, we can compare actual progress with anticipated progress. When an activity is done in the time planned, the line joining the points will run at an angle of 45° to the horizontal axis. Such a representation, he says, clearly shows the gains and losses in time and the operations and stages when they occurred. From scrutinizing the delays and ascertaining responsibility he argues that a proper award may be made.

Another graphical approach is suggested by Hughes (6), but this time the aim is to deal with the case where delays cause retardation of the project rather than a complete stop. To do this he plots time against expenditure (figure 1.9) and from the actual slope compared with the planned slope he is looking to identify the effects of any matters that are causing the contractor to proceed slower than he intended. If it is the employer's fault that the contractor is unable to proceed at his intended pace, then this may lead to a valid claim for prolongation. In the same book, Hughes considers the difficulties of handling concurrent delays: one of the major difficulties confronting any full solution to these problems. His remedy for these circumstances is analysed in some detail in a later chapter (chapter 3), but he goes on to say that from this basis (of dealing with individual periods of delay) a diagram must be built up for the whole period to



O-A represents the required rate of progress.
$B-B_1$ represents a week's stoppage, say for weather.

If work resumes at former tempo, further progress will be $B_1 - A_1$.

However, if rate of progress is not being achieved, then progress may be O-X, and weather effect $Y-Y_1$.

Work may then be resumed at its former tempo (Y_1-X_1), or may be mitigated (Y_1-Z). The contractor would in either event be entitled to his one week's extension of time.

Figure 1.9 Graphical Approach suggested by Hughes (6) show the interaction of causes. Extension of time considerations, he says, will apply only to those (causes) on the critical path (or a path made critical as a result of delays). This analysis is probably the most complete attempt discovered in the U.K. literature to provide a generalized mechanism for dealing with claims of this nature.

CHAPTER 2

USE OF CONTRACT PROGRAMMES OUTSIDE THE UNITED KINGDOM

In carrying out the literature search for this work, which is intended to relate specifically to civil engineering contracts in the U.K., it soon became clear that the matters being considered had been enquired into in more depth, or at least more detail, in the U.S.A.. Of course, the contract conditions in use in that country are different from ICE5, which is the contract form on which this study is based. That being the case, it was thought sensible to separate the review of literature from outside the U.K. from that covering the U.K. construction scene; hence the new chapter.

The material collected here relates to a number of contract forms, viz., A.I.A. (American Institute of Architects), A.S.P.R. (Armed Services Procurement Regulation), Corps of Engineers and G.S.A. (General Services Administration). Some relevant clauses will be discussed from these forms, but as a result of the diversity, no particular form will be examined specifically. There are, however, undoubted similarities between these forms and ICE5 in the area considered. Wickwire & Smith (25) confirm that many large construction contracts let by the federal government and private industry usually require the contractor to submit a contract programme. This is normally required within thirty to sixty days from the date of contract award. There is also a clear acceptance of the three main delay categories (E, C & N, as described in chapter 1), and a similar agreement on rights to extension of time, with or without overhead costs, that may result from these delays. The possibility of some form of liquidated damages payable by the contractor who fails to perform is also a common theme. Along with the similarities, there are also differences between the approaches in the U.S.A. and the U.K.. In particular, the forum for dispute resolution is likely to be an open court in the U.S.A.. In the U.K. most civil engineering disputes that cannot be resolved on site will be dealt with in a private arbitration hearing.

Although the majority of the texts contributing to this chapter are from the U.S.A., an important addition stems from the work of J.M. Antill, who has an Australian background. He tends, however, not to relate his work to a specific set of contract documents, but rather discusses the problems in general terms.

General Comments and Legal Principles

Writing in 1974, Wickwire and Smith (25) stated that CPM had by then become the standard method for dealing with delay claims in the U.S.A.. In the same paper they go on to describe a detailed standardized procedure for carrying out this type of analysis: reported in depth towards the end of this chapter. This approach is the most complete description of the use of CPM to resolve these matters that has been found, and certainly indicates a degree of development well beyond that described anywhere in the U.K. The authors do not pretend that adopting this method can be said to mechanize the production of a solution to these problems. They accept that there is still an essential role for the analyst to explain and justify the results thus obtained. As accepted in the U.K., Clark, writing in the Course manual of Construction Scheduling and Proof of Claims (26) confirms that a 'total cost' approach to claim substantiation is rarely acceptable. He says that additional costs must be justified on an individual basis in most instances. This view clearly supports the use of a CPM - based solution to these matters.

The picture is, however, not quite so clear. Rubin et al. (27) suggest that a CPM analysis with many activities could become impracticable and offers a solution based on the use of S-curves (see later). Sweet (28), writing in 1985, also reports that the A.I.A. have changed from requesting a contractor's schedule that was to be approved by the architect, to one that is for information only. This policy is intended to limit the architect's liability. It aims to avoid any implication that the contractor's schedule is reasonable in an attempt to help defend against any potential contractor delay claims. The frailty of the CPM approach has also been recognized by those who have used it. Rubin et al. (27) say that the validity of a CPM analysis is entirely dependent upon the validity of the assumptions made. They compare it to a house of cards in that if one assumption is proved incorrect, then the entire analysis may collapse.

Certainly the Americans cannot be said to have fully resolved this problem, as Hohns (29) affirms that these disputes typically take an excessive time to be resolved in the U.S.; up to 3-4 years and sometimes longer. 'Claims have to grow a certain amount of whiskers', he says,'they have to sit around and be studied and analysed. Everybody has to get used to the fact that they are there and will not go away.'

Alongside the possibility of claims for extensions of time, the concept of constructive acceleration is recognized as having to be dealt with in this context. Constructive acceleration is considered to have occurred when the contractor's 'perfected' right to an extension of time is denied and he is required to complete by the normal completion time. The contractor may then have a claim for the costs of working at an increased pace with its consequent lack of efficiency. Other scenarios analysed include the case in which a contractor's resource-scheduling has made all activities critical and the situation that arises when a contractor voluntarily completes much earlier than expected. In the first of these cases, Fondahl (19) comments that a contractor attempting to recover costs for delays in these circumstances will need particularly thorough documentation. Only then will he be able to substantiate the detrimental effects of the changes and delays. This is because in such a project, there is often no critical path in the conventional technological-restraint sense, some critical activities being resource-restrained. As most of the emphasis is on dealing with the effects of delays to the project, the consequences of what may happen if the contractor completes early are often overlooked. Sweet (28) points out that such an outcome can be just as disruptive as late completion. The owner may be required to find funds earlier than planned to pay the contractor and may not have any means of early earning capacity from the completed project.

In the U.S.A. there are three possible arenas in which the resolution of construction claims may occur. These are: Arbitration; Government Board of Contract Appeals; Court. The principal advantage of using arbitration is that the arbitrators will be experienced in construction practice. This is unlike the courts, where judges may hear a divorce suit one day, an accident case the next and a construction dispute the next. The number of cases being heard in arbitration, which is a private procedure, is growing but it still appears that relatively few cases of claims over $1 million adopt this approach. Contract Appeal Boards are the federal government's formal mechanism for resolving contract disputes and produce decisions that can be cited as legal precedent. The claimants may, however, bypass the boards and go directly to the U.S. Court of Claim if they wish. Notwithstanding these other two methods, both Hohns (29) and Rubin et al (27) record that the court is the favoured forum for such disputes.

Perhaps as a result of the knowledge gained as to how the judiciary views this sort of claim, some of the literature considers and makes recommendations on the way in which the claimant's case should be presented. Currie (30) states that in preparing these claims in the U.S.A., the services of a scheduling expert will typically have been employed, with the explanation:

> 'The same logic that requires the employment of structural engineers to assess reasons and responsibilities for structural failures, necessarily dictates that a scheduling expert be utilized when the project is affected by delays.'

The presentation in court, however, is recommended to be made by an attorney, who may also have been employed for some time in putting together the details of the case. Because of the complexity of the typical delay claim involving voluminous records, one suggestion is that a summary sheet be prepared. This will distill the relevant information from the reams of documents in which this information is found. Having established the validity of the summary it may then be used to represent the facts of the case. Writing on the difficulties of proving such claims, Clark (26) points out the need to differentiate between observable facts, proved by a percipient witness and conclusions as contained in the testimony of expert witnesses. He also points out that the burden of proof generally lies with the claimant. The standard of proof required is that the 'preponderance of the evidence' should point to the conclusions being drawn. In any event, it is well accepted in the U.S.A. that when adopting CPM to prove a right to the recovery of overheads or other costs/time, it is essential that the CPM presentation used in court relates directly to the actual job records. This is seen to be the single most important factor in determining the acceptability of a contractor's CPM-based claim.

In considering the legal principles governing these matters in the U.S.A., there is a distinction to be drawn between two types of generally accepted legal theories. The first of these, discussed by Clark(26) and Sweet(28) concern principles that may not be included in the written contract. They will, nevertheless, be available to give relief to the contractor should he have need of them. Such theories are in the nature of breach of contract and are quoted as:

i) breach of the warranty of specification suitability;
ii) fraud and failure to disclose;

iii) duty to co-operate.

Where a contractor has been delayed by reason of errors or other deficiencies in the plans or specifications prepared by the owner, he may assert a legal right to recover any damage occasioned thereby. This will rest on the theory that the mere presence of these errors or deficiencies constitutes a breach of the warranty of specification suitability (i). It is also a general rule that by failing to impart his knowledge of difficulties to be encountered in a project, the owner will be liable for misrepresentation if the contractor is unable to perform according to the contract provisions (ii). The third of these principles mirrors the U.K. equivalent regarding the contractor's remedy on the owner's failure to co-operate or actually to hinder the contractor's performance. It is quite probable that similar theories to the first two would be upheld in a U.K. hearing, if tested. However, even though the first of these is effectively written into ICE5, the point to be noted, perhaps, is that in the U.S. acceptance of these general rules is more clearly agreed.

In the second classification of legal theories, there appears to be general agreement on a number of specific issues relating to 'contract programmes' and their use in claims resolution. The issues are as follows:

i) Once a contract specifies a scheduling requirement, all parties may be legally bound to the resulting schedule and legal problems may arise where either party claims that the other has defaulted therein (Mitchell & Fitzgerald (31))

ii) Once the owner gives his approval to the contractor's schedule he binds himself to perform his contractual duties. These include supply of equipment, approval of shop drawings, etc.(Mitchell & Fitzgerald (31) and Wickwire & Smith (25))

iii) In similar vein, if the owner approves, or does not raise timely objections to a schedule submitted by a contractor, he will be bound by the schedule and expected to meet his obligations thereunder, (Mitchell & Fitzgerald (31) and Wickwire & Smith (25))

iv) Generally judicial decisions have held that no extension of time is justified when an employer-responsible delay has only consumed float time. However, to guarantee this there is an increasing tendency to state it in specification clauses (Fondahl (19) writing in 1975).

v) The general rule in the U.S. concerning government contracts is that notice requirements are valid and enforceable, but that delay in giving notice will not operate as a waiver unless the delay has prejudiced government (Clark (26)).

Clearly these principles will only hold in situations in which no other overriding matters take precedence. Nevertheless, to have arrived at a position where these issues can be generally agreed certainly shows a greater degree of development in this area than is found in the U.K.. There are, however, still a number of areas in which no agreement exists and in some cases owners have attempted to define the rules governing such areas by including a clause in the specification. This tendency will be considered in the next section.

Recommended form of the Contract Programme

Unlike the U.K., where suggestions as to the best form for the contract programme are difficult to uncover, in the U.S.A. the situation is reversed. There is in fact a great deal of information, principally in the form of clauses contained in the various forms of contract employed. Many of these appear to specify quite precisely how the programme should be put together. As an example, the Department of Defense (sic) has a number of 'regulations' for this purpose; selection of the relevant regulation being dependent mainly on the size and duration of the contract. Schor (32) provides full details of regulation DAR 7-604.7 which is intended to be used for complex jobs but that may be modified to accommodate individual projects. The full regulation incorporates instruction to the Contracting Officer on when to use it and how it may be modified before giving the clause itself. It is four pages long and defines the 'Contractor-prepared Network Analysis System'. Aspects covered by the clause are as follows:

i) The progress charts provided are to consist of a network analysis system, an example of which is referred to.

ii) Diagrams are to show the order and interdependence of activities and the sequence in which the work is to be accomplished. This follows the concept that shows how the start of a given activity is dependent on the completion of preceding activities etc..

iii) As well as activities detailing construction work, activities are to be included to cover:

* submittal and approval of samples of materials and shop drawings

* procurement of critical materials and equipment

* all activities of the government that affect progress

iv) The detail of information is to be such that duration times of activities range from 3 to 30 days, with not more than 2% of the activities exceeding these limits. The selection and number of activities to be approved.

v) For each activity, preceding and following event numbers, a description, cost and activity duration are to be specified. There is also, from the mathematical analysis, to be included details of event times and float, together with manpower required.

vi) A time-scaled summary network is to be provided where the entire network cannot be readily shown on a single sheet.

vii) Schedules of labour usage and plant usage tied to activities on which equipment will be used is to be provided.

viii) Lists of activities are to be provided sorted in a number of ways.

ix) Submission of a preliminary network for the first 60 days is to be followed by a complete network within 40 days of notice to proceed.

x) An approval procedure is laid down, following which departures from the approved schedule planned by the contractor are to be made known to the Contracting Officer. For major changes, he may require a revised submission from the contractor.

xi) Progress reports are required every 15 days involving an updating of the mathematical analysis. These reports are to show the portions of activities completed during the reporting period as these are used for payment purposes. There is also to be a description of problem areas and delaying factors and their anticipated impact.

xii) The size of CPM diagram drawings is also specified (30 * 42 inches).

Schor also reports on similar clauses to the above contained in Postal Service construction contracts, General Services Administration contracts and contracts let by the Washington Metropolitan Area Transit Authority for work on subway projects. In general, such clauses are recommended to be edited to suit the particular project being specified. Otherwise, information may be requested that will not be needed and that will merely delay submission of the schedule. It is not intended here to discuss each of these clauses in detail. However, as this is an area of particular interest, aspects not covered by DAR 7-604.7 or covered differently by these other clauses will be presented.

The Postal Services clause contains a number of sections dealing with issues not addressed by DAR 7-604.7 as:

i) The contractor is required to maintain a site staff trained in the use of scheduling systems whose sole responsibility is to monitor progress and update as necessary.

ii) If the contractor fails to submit revised progress charts when behind schedule, this failure may be considered as grounds for determination of the contract.

iii) Float is stated to be not for the exclusive use or benefit of either the government or the contractor. Extensions of time are only to be granted where the extent of time adjustments on affected activities exceeds the total float on the channels involved.

In a GSA prime contract, a clause has been adopted that requires the contractor to provide information to the architect so that the architect may develop the network plan. This plan is to be used by the contractor to carry out the work and he must also provide information necessary for the plan to be updated at intervals. This too will be done by the architect. It should be noted that the detail provided in these clauses (A.S.P.R., Postal, G.S.A.) is much greater than reported here and clearly indicates a considerable belief in the importance of schedules. There are, however, attempts on record to limit this importance by including clauses in contract conditions that deny the contractor any remedy for delays for which the owner is responsible. Such clauses, known as 'no-damage for delay' clauses or 'exculpatory' clauses merely muddy the issues. As Sweet (28) says, they are not attractive to courts and under some limited conditions will not be given effect.

As well as specific instances of clauses defining the format of the contract programme, there is also some advice available in the literature on these matters. The first piece of advice to be considered, from the Association of General Contractors (U.S.), is obviously a reaction to the clauses just discussed and recommends that,'...owners and architects should be extremely careful in specifying CPM. 'Forcing this system', they say,'by specifying cannot only reduce the scope of bidders, but can also introduce confusion, misunderstanding and hard feelings on the part of those who are forced to use it' (Schor (32)). On the subject of preliminary schedules obtained prior to the main project schedule, Driscoll (33) advises that these should be avoided. He recommends getting a contractually agreed schedule as soon as possible. Both he and Antill (34) recommend the use of time-scaled networks as promoting easier comprehension of the intricacies of critical path planning; especially for claims presentations in court. Looking forward to the claims situations that will inevitably occur, Antill also suggests that contractors be required to reference on their contract programmes not only the initial critical path but also the second and third longest paths through the project network. This is clearly suggested in an attempt to ensure that the parties do not concentrate fully on the one planned critical path to the exclusion of others. It will allow them to see just how close to critical any other path through the network is.

Recommendations for checking the Contract Programme

As with the U.K. construction scene, no specific guide-lines have been uncovered that set out an ordered approach to the best way of checking the contractor's contract programme. There are, however, a few contributions that are considered to be relevant. Driscoll (33), while not dwelling on this area, does say in passing that most disputes over the initial schedule generally involve level of detail, the use of vague logic, excessive durations, the use of manpower restraints and preferential logic that cause critical or near critical paths of float (sic). Other comments relate either to activity definition, the way in which the network has been put together or to the submission and approval process.

Antill (34), whose recommendations for using CPM to validate extension of time claims will be presented later, also makes a number of points concerning the durations and form of programme activities. He suggests that such activities should not exceed one month in duration, excepting design and procurement activities that progress steadily from start to finish and that require no change in manpower or equipment. He goes on to say that the breakdown of a project into its activities must be such that all operations that might be affected by work changes and delays should be able to be individually identified. With regard to the form of these activities, Antill classifies them as continuous or intermittent depending on whether once started they must be completed without interruption, or whether it may be practicable to do part at one time and the balance later.

Both Jafaari (35) and Driscoll (33) recognize that the network constructed to represent the construction of a project is seldom a unique solution and that alternative networks might be equally valid. Indeed, Driscoll believes that for building construction, as much as 40-50% of the network logic could be preferential rather than absolute. This fact is also referred to by Wickwire and Smith (25). In discussing the contractor's initial CPM schedule, they recognize that this schedule need not be the only way (to carry out the work) but must be economical in cost and time. The contractor's schedule will usually incorporate two types of link between activities. These are logic links and resource links, and Fondahl (19) points out that activities on the project's critical path may well be resource-restrained rather than technologically-restrained. Such factors as these may clearly be important when checking the contractor's programme.

In discussing the submission of the contract programme for approval, Driscoll (33) sees this in terms of a check that the owner-related functions outlined in the contract documents are properly incorporated into the schedule. From the contractor's viewpoint, acceptance of his schedule for what it is within a reasonable period of time may well be very important and Mitchell & Fitzgerald (31) include a sample letter from contractor to owner for this purpose. The letter points out that activity durations shown are estimates and not commitments and that some of the items of work will be paced by or dependent upon actions of the owner. It concludes by stating that the schedule will be assumed to be acceptable unless the contractor is informed otherwise within thirty days. This ploy is presumably in recognition of the fact that such programmes may often be ignored by the owner, perhaps in an attempt to reduce their future claims potential.

Methods of dealing with Delay Claims

The problem to be dealt with in this section is the prime consideration of much of what has been written in this area. That is, given the complex situation that inevitably arises on many even moderately-sized contracts with a number of delay effects impacting the final completion of the project, who should pay for any subsequent delay of the project as a whole? The background, which was briefly described in chapter 1 will now be given in detail, prior to a description of the main methods found in the literature outside the U.K. for dealing with these matters.

By no means all of the changes made to a contract will delay the project. Some will involve changes in detail that merely affect the nature of the work to be done without increasing its difficulty, requirement for resources or duration. Other changes will actually reduce the work to be carried out. There will, however, typically be changes that do delay, increase the duration of or force a change in sequence in the activities making up the contractor's contract programme. As we shall see from what follows, the impact of such amendments on total project time cannot be easily predicted at the time the events occur. Also the responsibility for the delays must be known if decisions on claims for extensions of time are to be made on a proper basis.

Delays to parts of the contractor's programme (which may not necessarily cause delays in the project as a whole) are most helpfully categorized as follows:

i) those for which the employer (also known as promoter, client, owner) or his engineer (architect, adviser) is responsible (E);

ii) those for which the contractor is responsible (C);

iii) those for which neither party to the contract is responsible (N).

In the U.S. literature, these are usually called compensable (E), non-excusable (C) and excusable (N), and some of the main reasons for delay encountered under these sub-divisions are:

i) changes to the contract documents; failure to provide land or information within a reasonable time and failure to approve the contractor's method of working expeditiously;

ii) inadequate supervision and technical support; late agreements with subcontractors/suppliers; insufficient labour/plant;

iii) strikes, riots and exceptional adverse weather.

As stated in chapter 1, there appears to be a general consensus as to the rights to additional time and payment for such delays (where warranted) in all contract forms encountered. This is repeated here as:

Delay type	*Award*
E	Extension of time + extended overhead costs
C	No compensation
N	Extension of time without extended overhead costs

Again it is worth stressing that it is dangerous to generalize on contractual matters. For any particular contract, it is the actual conditions used that must be consulted to ascertain liability for these delays. However, providing this is understood, it is perfectly acceptable to proceed on this basis.

Before examining the methods adopted to analyse the effects of these delays on the contractor's programme, it is important to consider the status and contractual significance of this document. Antill (34) suggests that use of CPM in this context requires that the programme forms part of the contract and is presumably submitted when the contractor puts in his tender. It might then be argued that a programme that the contract conditions require to be provided within a set time from acceptance of tender, as happens with ICE5, does not fulfil this requirement. The following quote from Abrahamson (2), which although clearly related to the U.K. environment is sufficiently universal to apply, does, however, help to clarify the matter:

> 'An habitual question in the industry is whether or not a programme or other information given by the contractor is part of the contract. The question is meaningless. The programme, for example, is not contractual in the same sense as the specification, since neither the contractor nor the employer is bound by it. The programme is what it is - a document indicating the intention of the contractor at the time he furnishes it as to how he intends to programme the works, and may be used in evidence against or (subject to serious limitation) for him.

It would seem then, that providing the programme is the most convincing method of proving or disproving delay claims (which given the right conditions it probably will be) that its acceptance as part of the contract may not be obligatory. Two additional points should be made at this stage:

i) The contractor is expected to carry out both contract and varied work in an efficient manner and should take all reasonable steps to mitigate any delay. If he behaves unreasonably this will affect any claim he may make.

ii) It is not enough for the contractor to base his claim for an extension of time on his initial programme: it is his actual not his planned progress that is relevant.

The methods to be described for assessing the validity of these claims are as follows:

1. The Method of Factual Networks
2. The Use of Adjusted CPM Schedules
3. Time Impact Analysis
4. The Use of S-curves

It should be noted that methods 1,2 & 3 all comply with the point made in (ii) above, in that they all use the network to record and analyse what actually happened on site.

1. The Method of Factual Networks

From the work of J.M. Antill (34,36), the concept of factual networks aims to establish a principle for the determination of time and costs in the environment just described, and to do that for any eventuality. The factual network may be usefully compared to the as-built drawings prepared throughout a contract, which on completion will provide a full factual representation of the actual work carried out on the contract. For as-built drawings, this is principally in terms of the materials used at the various locations. In like manner, the factual network records actual starts and ends of all activities making up the project and also records all work changes and delays encountered. The same activities as those found in the contractor's initial programme will be present in the factual network (but with actual rather than planned durations). It will also include any other activities required as a result of amendments during construction. The factual network is thus a detailed schematic record of the work as it was constructed together with an authentic account of all the relevant occurrences that had any effect upon the performance of the contract.

In order to provide the information from which the factual network can be built up, the following records will need to be kept:

i) the status of each activity must be assessed on a regular basis, together with reasons for delay (if any);

ii) each day a record must be made of activities that have started on that day and of those that have been completed;

iii) for each delay to the works (from whatever cause), a record must be entered of the extent of the delay and the activities affected.

At first glance it might be assumed that only those delays that could lead to an extension of time for the contractor need be recorded here. However, to do so would lead to an unfair assessment of the situation. Where concurrent delays occur on parallel activities, only one of which is outside the contractor's control, it is suggested that the contractor cannot claim delay to his operations as a result of the delay for which the employer is responsible where delays under his control also prevented him from proceeding. Thus, all delays must be considered as the actual effect of any delay cannot be properly judged until the project is complete. This systematic and logical approach to the recording of what happened during construction allows the facts of the matter to be established. As the intention is to use these facts to prove or disprove contract claims it is clearly preferable if they can be mutually agreed between the contracting parties.

As well as recording the information in a tabular form, it is recommended that the factual network be plotted progressively as construction proceeds. This is best achieved by using a time-scaled network for both original programme and factual network. Indeed, if the factual network is plotted on a transparent sheet using the original event numbers, then the system may be used to provide an immediate comparison between what was planned and what has been achieved. This is clearly also helpful for control purposes. On the factual network, activity durations will of course include the various delays that have occurred. Delay times may be distinguished from normal activity times by use of a different convention on the lines representing the factual activities.

When the project is complete, with all activity durations, sequence changes and delay effects recorded, the factual network may be analysed in the conventional manner. That is by carrying out a forward and backward pass to determine the critical path. If more than one critical path results, then the primary factual critical path, the one with the largest net working duration, must be determined. The net working duration of any path through a factual network is found by deducting from its total duration the delay times of those work changes and delays (and only those) lying on the path being analysed. The procedure is therefore as follows:

i) Carry out a forward and backward pass through the factual network.

ii) If only one critical path results from (i), this is the primary factual critical path.

iii) If more than one critical path results from (i), assess the net working durations of each critical path. The primary factual critical path is the one with the longest net working duration. The secondary factual critical path is the one with the next longest net working duration, etc..

The importance that Antill attaches to the primary factual critical path in determining responsibility for critical delays is demonstrated in the following quotations (34):

> 'It will be obvious that any path through a network may be analysed if it is of interest to inquire why it has undergone tardiness; but it is emphasized that the overall effects of all eventualities to date on a project as a whole are determined solely by analysing its primary critical path.'

> 'The responsibility for project delay up to any given date may thus be accurately determined by examining critical delays alone; no other occurrences, whatever the cause, affected the performance of the work as much as those on the primary factual critical path.'

The possible existence of other critical paths, however, is admitted. In a given situation, where only certain types of delay entitle the contractor to recompense, Antill merely states that the contractor's proper entitlement is solely the delay times of those specific occurrences that lie on a critical path.

The procedure just described is of a retrospective analysis when the project is complete, but it may well be necessary for the employer to consider the case for an extension of time claim part-way through the contract. This may be achieved by determining the current critical path at the date of the assessment and extending it with an estimated network to completion. This should be based on performance in the contract up to that date. The current critical path, we are told, is found by retracing through the network from the event most behind schedule at the time of the assessment to find those activities having no float.

2. The Use of Adjusted CPM Schedules

As previously explained, the use of CPM presentations to establish construction contract claims in American legal proceedings is now widely accepted. Wickwire & Smith (25) have suggested a possible approach to proving delay claims based on the precedents set. As with the method of factual networks, the records detailing when activities took place and the effects of the various delays are an essential requirement. Indeed, it is suggested that the single most important factor in determining the acceptability of a contractor's CPM-based claim is the need to relate the CPM presentation in court to the actual job records. Just one error in correlating the CPM presentation and the job records can throw doubt on the whole presentation. A case on record in which the CPM presentation was discounted showed electrical work being performed during a period when no electricians were on the payroll. Unfortunately, the ideal situation in which a presentation is put together from a carefully prepared and logical initial network, properly updated as actual work progressed is said to be rarely encountered. Rather, it is likely that actual construction will differ from the initial network. This will be not only in miscalculated estimates of activity durations, but also as a result of logic errors being discovered in the initial network and from time-saving techniques arising from additional knowledge gained during construction.

Obviously then, these considerations must be accommodated in any procedure for dealing with such claims and the approach adopted here enables this by the preparation of four CPM diagrams:

i) a reasonable 'as-planned'CPM;
ii) an 'as-built' CPM;
iii) an 'as-built' CPM reflecting all delays - those for which the employer, the contractor and neither party are responsible;
iv) an 'adjusted' CPM to establish completion of the project in the absence of employer delays.

Each schedule should be accompanied by an analysis of the project records to demonstrate the basis for the data used and again it is recommended that a time-scaled network be adopted for plotting the diagrams.

i) The Reasonable 'as-planned' CPM

The main reason for constructing this diagram is to determine the precise time schedule and sequence of construction the contractor planned to use in constructing the project. This may not be the optimum plan as more clearly viewed in hindsight, but it is suggested that it should be shown to be economical in both cost and time. However, where errors in the plan are discovered during construction, it will generally be more helpful to incorporate and correct such errors and to produce a 'realistic' reasonable 'as-planned' CPM. The errors may result from time-saving techniques, errors in logic or errors in activity durations. Clearly where this procedure is adopted, the result will be a plan establishing the time the project would have been completed in the absence of any delays, as durations will be actual time spent working on the activities. As always, the diagram should be accompanied by an analysis showing detailed sources of information and in particular spelling out the reasons for changes from the initial network submitted by the contractor. Figure 2.1 is a simple example of a reasonable 'as-planned' CPM.

ii) The 'as-built' CPM

If proper records are available of the starts and ends of all activities, then the preparation of this diagram will be straightforward. Sources of delay are not highlighted in this section although the effects of delays will be included by using the actual dates concerned. This CPM diagram, therefore, details what actually happened during

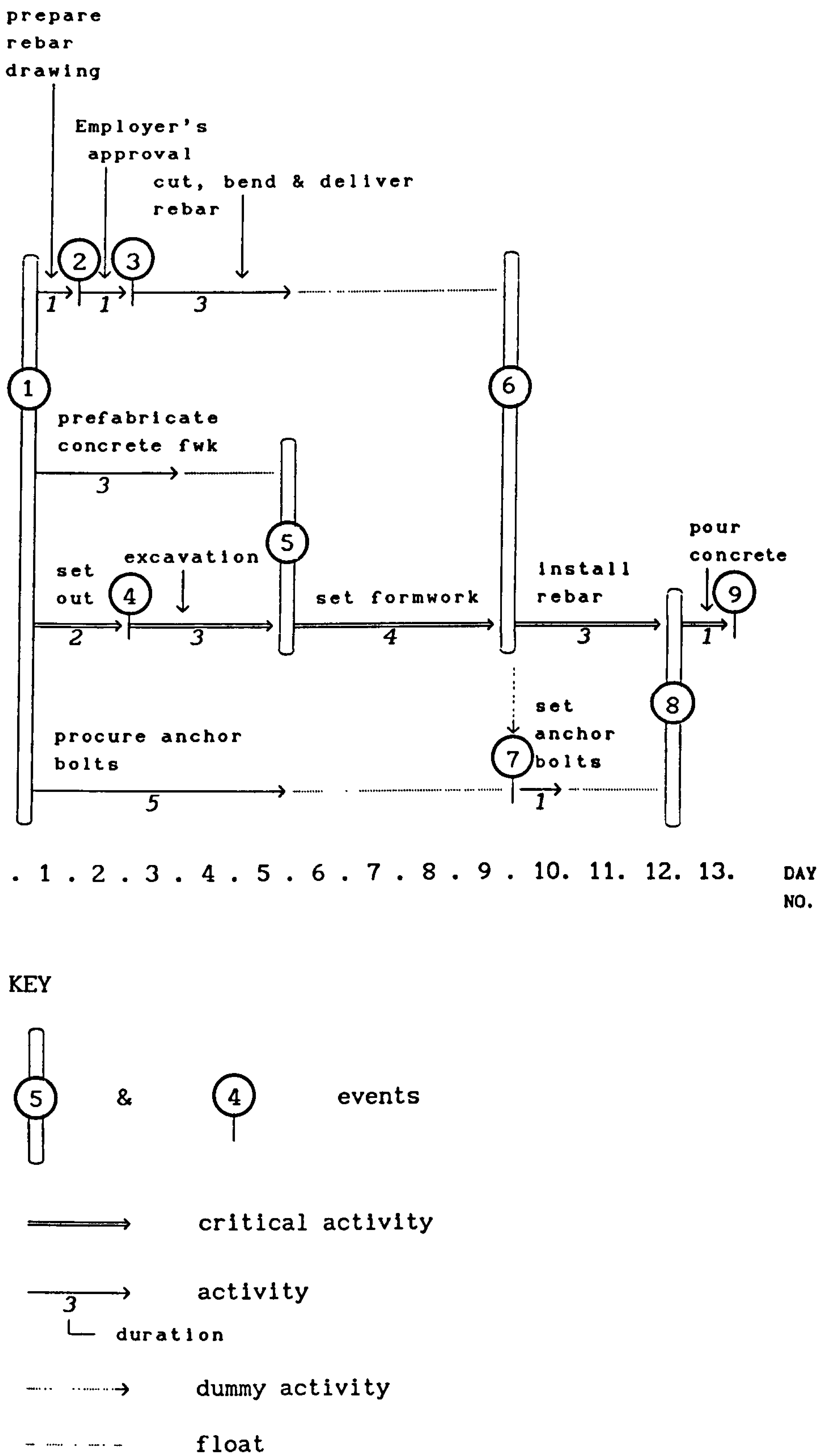


Figure 2.1 Reasonable 'as-planned' CPM

construction, and care must be taken to check the dates shown against all project records, viz., diaries, progress meeting minutes etc..

The accompanying analysis should indicate areas where the 'as-built' and 'as-planned' diagrams concur and those areas where the two differ. It is also important to highlight the actual critical path(s) that dictated the project completion date. To complete the analysis an explanation is required of the effect that any change in duration or sequence had upon the completion date. In this respect, the normal expectation that a delay on a critical activity will lead to an equivalent delay in the project may not actually hold. There may in fact be no delay if additional resources are employed. Equally, the actual delay to the project may be considerably greater than the activity delay if (say) a weather window is missed as a result.

iii) The 'as-built' CPM reflecting all delays

This diagram may be considered as an overlay on the previous 'as-built' CPM. It serves to segregate the delays and any knock-on effects encountered into those for which the employer or the contractor or neither party were responsible (delays type E, C and N respectively). It is recommended that a colour code be adopted to differentiate these various types of delay. The analysis to accompany this diagram will be very similar to that provided for the 'as-built' CPM but should also include the reasons for each delay. Figure 2.2 provides an example, which without the annotations indicating responsibility for delay, may also be seen as an example of an 'as-built' CPM.

iv) The 'adjusted' CPM

If we wish to know the effect that the delays attributable to the employer (type E) had on completion of the project, we must now pull out from the 'as-built' CPM reflecting all delays, those type E delays that affected the critical path(s). This having been done, however, what remains may not be sensible. The delays type E may have so changed the sequence of construction that both activity durations and sequences may have to be adjusted before a reasonable plan results. Indeed, it is possible for the plan produced by the first stage of the above process to indicate an order of construction that contains inherent contradictions, since the adjusted durations might be impossible considering the changed sequence. Any amendments made in the second stage of the above process will need to be fully recorded and justified in the analysis that accompanies this diagram.

(Wickwire and Smith do not mention this, but it seems that having completed the above process, the new critical path might still include delays for which the employer was responsible. If this were so, the process would surely

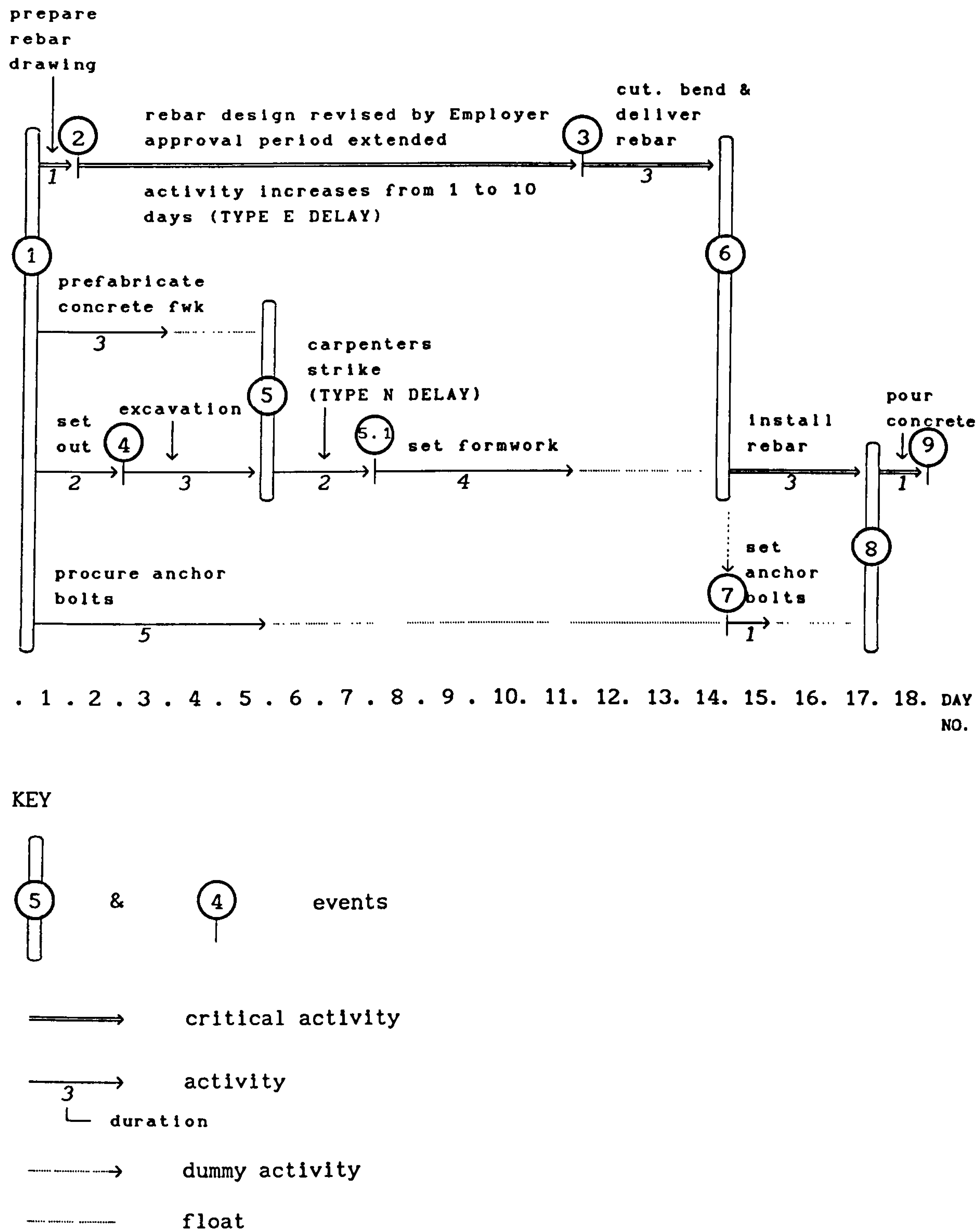


Figure 2.2 'As-built' CPM reflecting all delays

have to be repeated until no type E delays existed in the final critical path.)

When this whole procedure has been finalized, the amount of delay for which the employer is liable .in terms of both cost and time is found by the difference in time between the actual completion date and the completion date shown on the 'adjusted' CPM. Figure 2.3 provides an example of an 'adjusted' CPM.

Even in the simple networks shown to illustrate the method, it is evident that while only critical paths need be considered to ascertain the project completion date, that previously non-critical paths may also need to be taken into account when determining liability for delays. Thus path 1-4-5-5.1-6-8-9 which was not critical in the 'as-built' diagram becomes of particular importance when the 'adjusted' CPM is prepared.

3. Time Impact Analysis

This technique is reported by both Galloway & Nielsen (37) and Driscoll (33), although the latter appears to be the main source of inspiration for the former. In essence, as each change or delay occurs to the contract, a time impact analysis must be conducted to document the effect on the project schedule. This is perhaps best explained by looking at the procedure that it is recommended should be

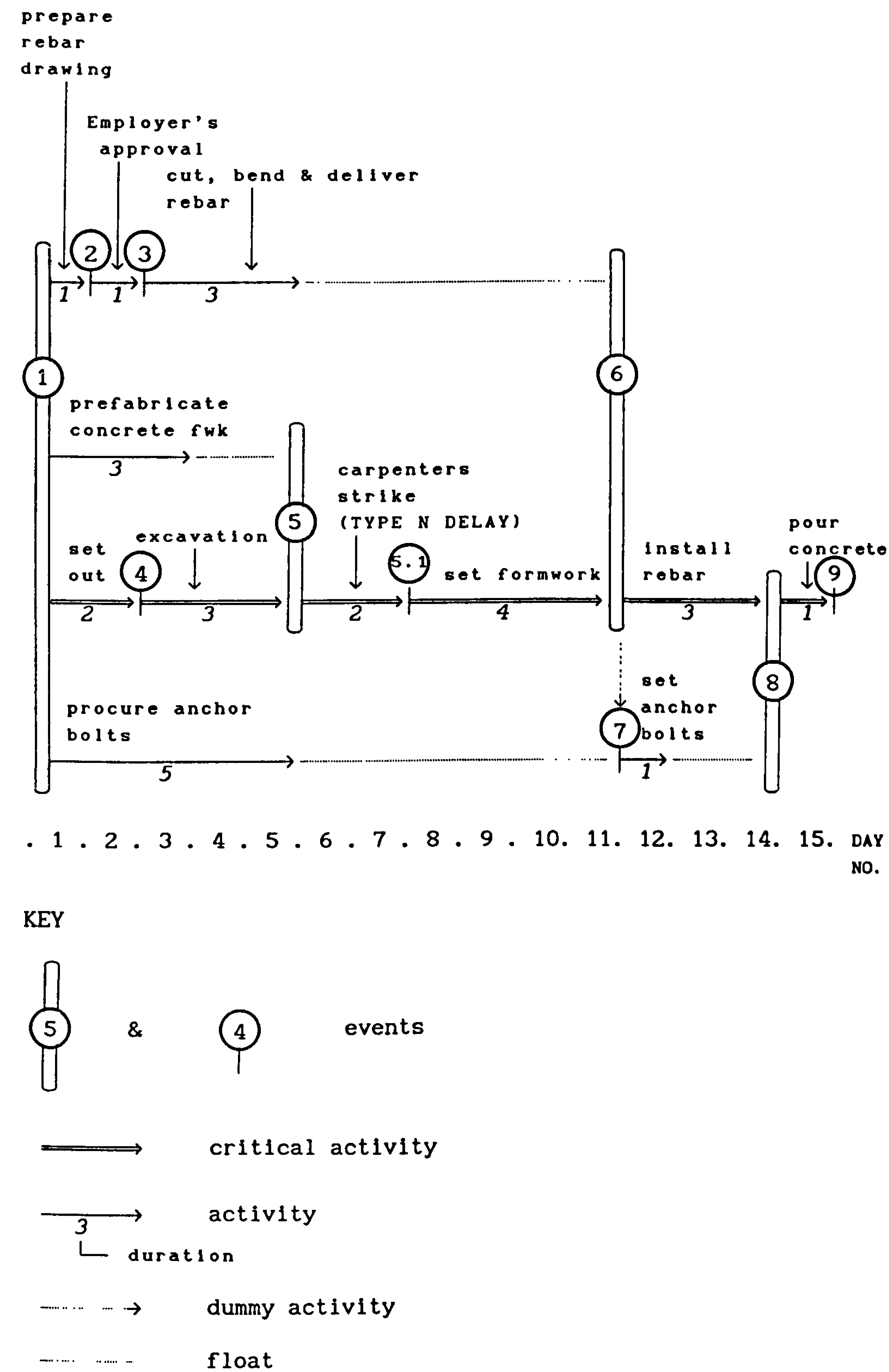


Figure 2.3 'Adjusted' CPM

complied with by the party carrying out the analysis. For each delaying effect then, the following activities will need to be executed:

i) study the scope of the change or the extent of the delay;

ii) review all reference material, viz. drawings, correspondence etc.;

iii) ensure that all contracting parties comply with the change;

iv) determine each activity affected or restricted by the change;

v) review event times for affected activities resulting from amended durations;

vi) determine the status of activities in progress that are impacted when the change is issued or the delay occurs;

vii) check any effect on the sequence of activities (may require the use of a 'fragnet' - a fragment of a network);

viii) prepare an independent schedule analysis to derive a time impact position to be taken during negotiations;

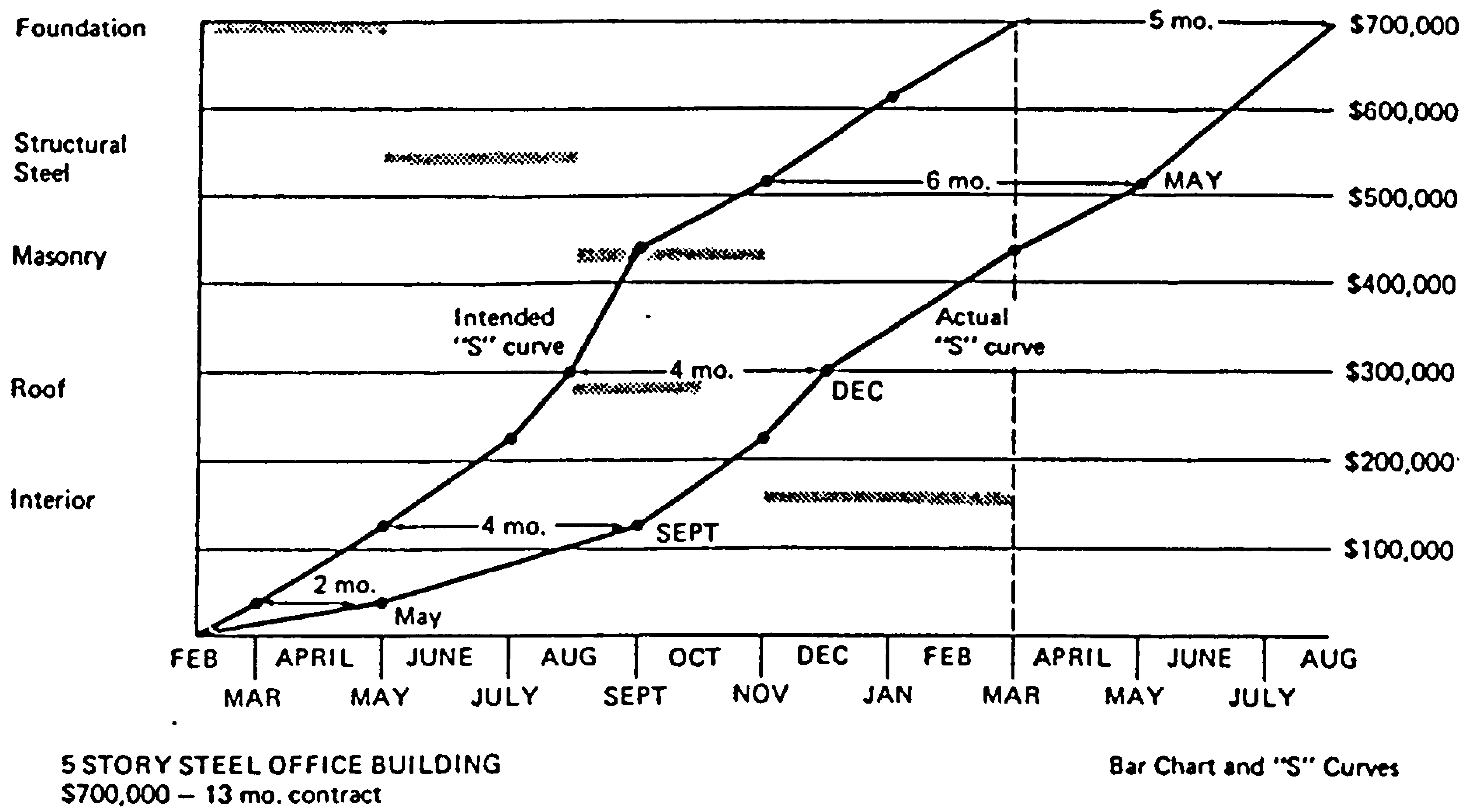
ix) check that any time extension of the project is a product of the change and not a result of other reasons the project is behind schedule;

x) document the time impact of the particular delay considered.

Providing the schedule used at the start of this procedure is current, i.e., all previous changes and delays have been incorporated, then it is argued that the resulting schedule may be used to recommend possible extensions of time. In fact, Driscoll reports that this approach has been used successfully on a number of major projects: those where CPM was,'used, abused or not required at all.' There are clear similarities with the 'adjusted CPM' approach in that the 'as-built' CPM should look very much like the schedule achieved at the end of the contract using time impact analysis. The documentation will presumably also be very similar on both approaches; each one attempting to provide the essential information to permit a clear understanding of exactly what occurred during construction. However, the time impact technique appears not to appreciate that subsequent activities beyond those currently completed on what is shown to be the initial critical path may not be achievable. It could, therefore, be argued that before any extension of time is considered, that the engineer should reconsider that part of the plan that lies beyond the date for assessment. This should be done to determine whether, on this outstanding work, the contractor is likely to be able to achieve what he says he can in the light of his performance to date.

4. The Use of S-curves

As stated in an earlier part of this chapter, Rubin et al (27) have suggested that a CPM analysis with a number of activities could become impracticable. They recommend a solution based on the use of S-curves. Referring to figure 2.4, this approach requires that the time/cost S-curve for the contractor's original plan be calculated and plotted on the same axes as the S-curve representing his actual income. This second curve must exclude any costs for additional works so that the comparison of the two curves in this way is valid. Having achieved this, the argument put forward is that at any point along the actual S-curve, the horizontal distance between the two curves indicates the duration that the job is behind schedule at that date. This information is purported to be helpful in,'ascertaining whether the job is behind schedule for purposes of termination of contract and orders to accelerate the work.' The approach is clearly in the realms of a 'total cost' procedure and as such is clearly less convincing than a CPM analysis for this reason.



The above diagram shows the time/cost S-curve for the contractor's original plan and also the S-curve representing his actual expenditure. On the same diagram is plotted the bar chart for the main activities. At any time, the contractor's actual progress in terms of money spent can be compared with his actual progress. For instance, in May of the second year, the job was six months behind schedule.

Figure 2.4 Use of S-curves suggested by Rubin et al (27)

However, the authors say that it is often used. It is clearly a considerable simplification in that the progress of the works, which may be proceeding on a number of fronts, is represented by a single factor: that of contractor's income.

CHAPTER 3

THE PROBLEM OF CONCURRENT DELAYS

A number of methods of dealing with time claims on contracts have been presented in the previous chapters, and it is clear that for those methods recommending use of CPM networks, the analysis can become quite cumbersome. This happens as a result of trying to model a complex set of circumstances that have taken place over what can be a considerable period of time. It should be realized, however, that yet more complexity may have to be dealt with even in the smallest of contracts. One particular difficulty not covered by the most intricate of these previously discussed methods is that of concurrent delays.

The problem of concurrent delays has been recognized as particularly onerous by several writers as the following quotes indicate:

> 'The literature has often recommended the critical path method, but writers usually fail to discuss the problem of concurrent delays.
>
> In fact, delays can be caused by several parties, contracting parties, or others; consequently the effects and remedies vary from case to case. Concurrent delays are two or more delays occurring at the same time and have always been difficult to resolve.'
>
> Kraiem & Diekmann (38)

> 'The thorny problem of concurrent delays has already been mentioned. Decided cases about similar but not identical issues in different settings are not very helpful. The general rule would seem to be on principle that if the employer's actions do not actually delay the contractor because, for example, he was not in any case ready for drawings held back, or the contractor cannot prove which of several causes for only one of which the employer was responsible was the operative cause of the delay and his losses, having failed to discharge the burden of proving loss due to the action of the employer the contractor is not entitled to recover compensation from him.'

Abrahamson (2)

In this chapter, ways of dealing with concurrent delays reported in the literature will be analysed, hopefully leading to a better understanding of the real situation. To begin with, we need a definition of exactly what is meant by the term 'concurrent delays' and for the moment, the definition quoted by Rubin et al. (27) will be adopted. This states that concurrent delays is a term used to describe two or more delays that occur at the same time, either of which, had it occurred alone, would have affected the ultimate completion date. Towards the end of the chapter, we shall see that this definition is inadequate and must be modified if it is to cover all eventualities.

The use of models

The idea of constructing a model to help solve engineering problems is most certainly not new. In structural engineering, conceptual models, often these days held in computer storage or actual physical models of a structure tested to determine design parameters are commonplace. The structure under consideration is idealized to allow a solution to be obtained, but not so idealized that the solution does not relate to the real-life structure being examined. Models, physical or otherwise, are an essential means adopted by engineers to permit them to understand their problems better and to determine the relevant information needed to allow them to produce a design for their project. Typically the required data is in the form of bending moments, shear forces and bearing pressures, in the structural field or maximum discharge, fluid pressure and fluid depths in the hydraulics area.

In a somewhat similar way, as we have seen, the critical path method of modelling project progress has been used to solve problems involving construction disputes. In this case, however, the model is not used to determine physical attributes, but rather to assess the use made of project time and finances. The main dilemma, of course, stems from the fact that the contractor on any reasonably-sized contract has always priced for a set of circumstances that will never occur. He must construct in an environment and to details that will inevitably, in the event, always be other than what he could have expected at tender stage. Nobody who has had any degree of involvement with the construction industry is surprised by this fact. It does, of course, mean that the contractor's costs are no longer what he could have predicted and that to some extent a revised cost and time for the contract needs to be deduced. When the changes involve additional work but this has been achieved without delay to the contract, the adjustment is just a matter of agreeing increased costs. (Use of the word 'just' here is not intended to indicate that this is always an easy matter). However, when delays have occurred for which the contractor is not responsible and that have caused the whole project to be delayed, the resolution of this problem is much more difficult. In practice, the difficulties are often compounded by delays to different parts of the project occurring at different stages of the contract and being attributed to different parties. It is here that the CPM network model has been adopted, and it is used in such circumstances to attempt to predict an outcome in terms of project time and cost that would be equitable to all parties. The attribute being sought here by use of the model is therefore some measure of justice.

The models used by structural engineers have, of course, been refined and amended over many years to improve their ability to predict those properties essential to allow structures to be designed. It should, therefore, be readily accepted that the use of CPM models as described above may also need to be revised and improved to provide a better and more realistic model of construction disputes and their resolution. The following section deals with three ways in which concurrent delays have been considered in the literature. The subsequent section will indicate the problems associated with these approaches and attempt to point towards an improved solution.

Methods of dealing with concurrent delays

Having established the facts of the matter, by producing a CPM model indicating the various delays which occurred during construction, together with the record of when work actually took place on the project's activities, the next step is clearly to analyse this model. The purpose of this analysis is, of course, to determine whether the contractor was due an extension of time for the project, with or without costs, and/or whether the employer should deduct liquidated damages. It is at this stage that the issue of concurrent delays will probably have to be considered, and the following sections describe different approaches to this problem, which have been offered.

1. First cause defines liability

The philosophy behind this procedure, which is proposed by Hughes (6), is that once the job is stopped by one cause of delay, it cannot be any more stopped by another delay, unless and until the second delay continues after the first delay has ceased. The argument put forward is that liability must rest with the party responsible for the first delay encountered for the duration of this delay.

Subsequent delays that occur during the period of the first delay should not affect liability. This is illustrated by the diagrams shown in figure 3.1. For diagrams 1(a) to 1(d), where an initial delay is caused by the contractor (C) but subsequent delays attributable to both employer (E) and neither party (N) occur, the argument is as follows:

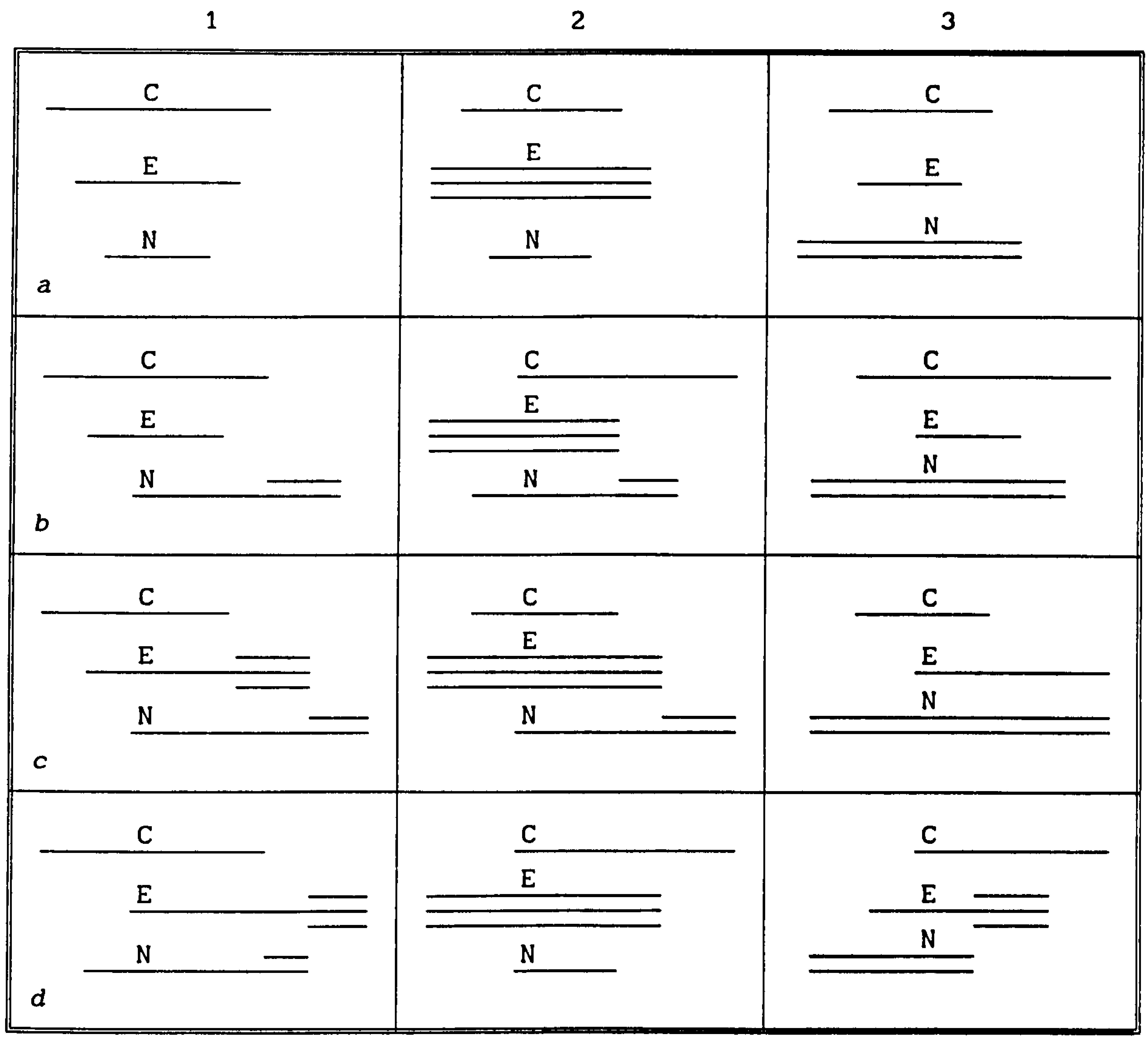
1(a) - the initial delay type C continues beyond the end of both delays type E and N and thus no resultant claim is justified.

1(b) - delay type N continues beyond the end of the initial delay type C giving rise to a possible extension of time.

1(c) - the second delay type E continues beyond the end of the initial delay type C giving rise to a possible extension of time with costs. Delay type N continues beyond the end of the second delay giving rise to a possible extension of time

1(d) - the second delay type N continues beyond the end of the initial delay type C giving rise to a possible extension of time. Delay type E continues beyond the end of the second delay giving rise to a possible extension of time with costs.

Hughes points out that this exposition refers only to



Delay which is responsibility of:

contractor - marked C
employer - marked E
neither party - marked N

Possible extension of time only shown

Possible extension of time with costs shown

Figure 3.1 First cause defines liability individual periods of delay considered separately. He states that a diagram must be built up for the whole period of the project to show the interaction of causes so that costs arising from them may be properly allocated. Extension of time considerations, it is stated, will apply only to those delays on the critical path (or a path made critical as a result of delays).

Whether this approach is seen to have merit, and it must be accepted that it is quite out of step with the other methods to be discussed, it does at least help to illustrate part of the complexity with which we are attempting to deal. More detailed comments on this system will be found under discussion of the methods.

2. Adjusted CPM schedules

This approach, well documented by Wickwire & Smith (25), is the basic treatment of delays using CPM diagrams. While it does not mention concurrent delays as such, the method does deal with some concurrent delay situations. The procedure entails the preparation of four CPM diagrams in order to determine each parties' rights in a project where delays have occurred. These are:

i) a reasonable 'as-planned' CPM;
ii) an 'as-built' CPM;
iii) an 'as-built' CPM reflecting all delays - those for

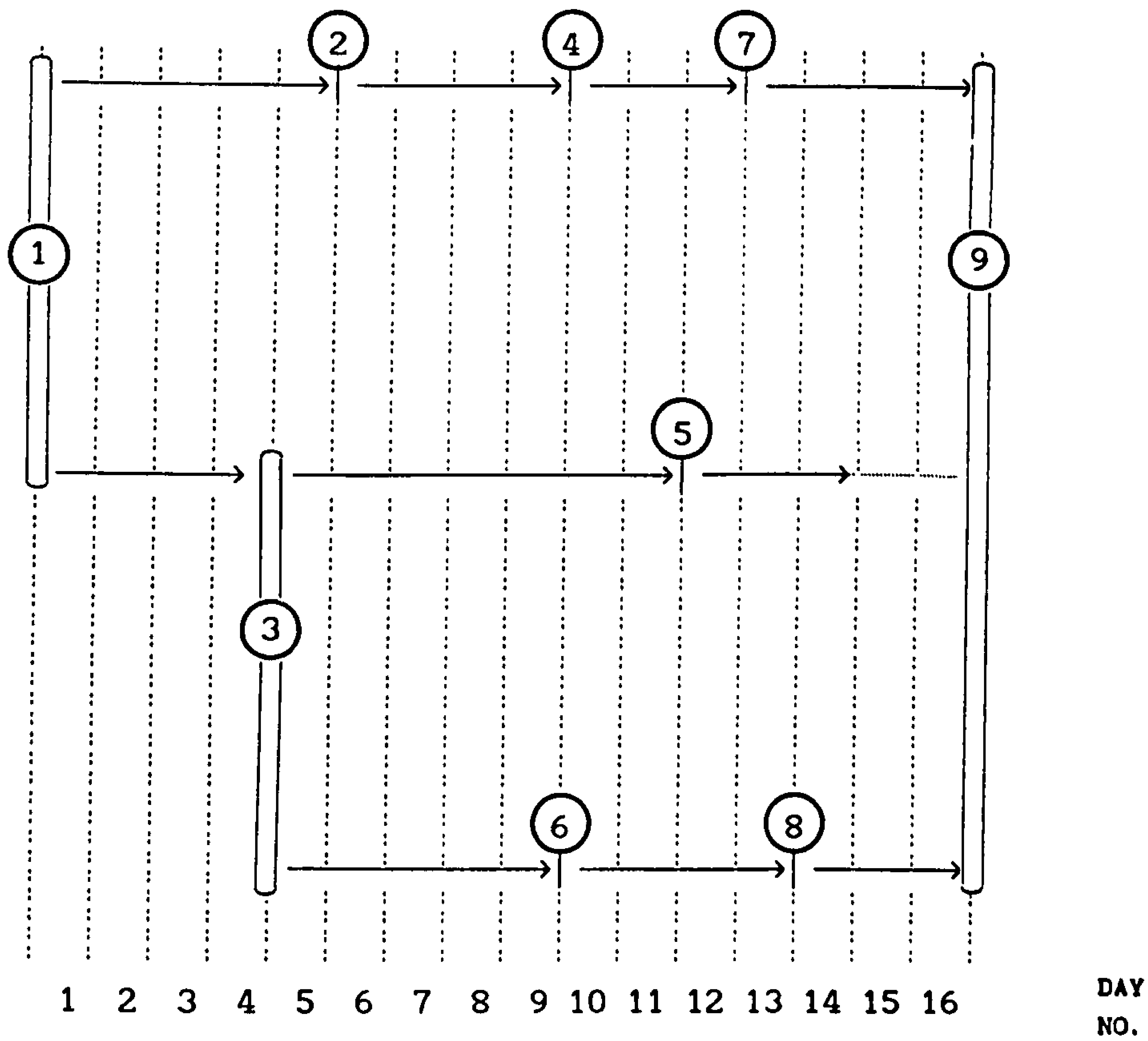
which the employer, the contractor and neither party are responsible;

iv) an 'adjusted' CPM to establish completion of the project in the absence of employer-responsible delays.

A full description of this method was given in chapter 2 and there is, therefore, no need to reiterate this information. However, so that the methods of dealing with concurrent delays can be sensibly compared, figures 3.2, 3.3 and 3.4 have been included as examples of (i), (iii) and (iv) above. Although, as previously mentioned, this approach has not attempted to deal with concurrent delays per se, we can see from figure 3.3 that the 'as-built' CPM did contain 4 days 'concurrent' delay on days 10,11,12 & 22. This was due to the fact that two critical paths existed along paths 1-2-4-7-9 and 1-3-6-8-9. This was not considered in arriving at the solution, and yet a solution has been obtained in line with the suggested method.

3. Date assessment of concurrence

The procedure adopted in this approach to delay analysis is described by Kraiem & Diekmann (38). It relies on American legal interpretations of the remedy for the compound effect of any combination of delays due to different causes. These remedies are summarized as follows:



<u>KEY</u>

Delay for which the employer is responsible

Delay for which the contractor is responsible

Delay for which neither party is responsible

Activity

Float

9 & 4 Events

Figure 3.2 'As-planned' CPM

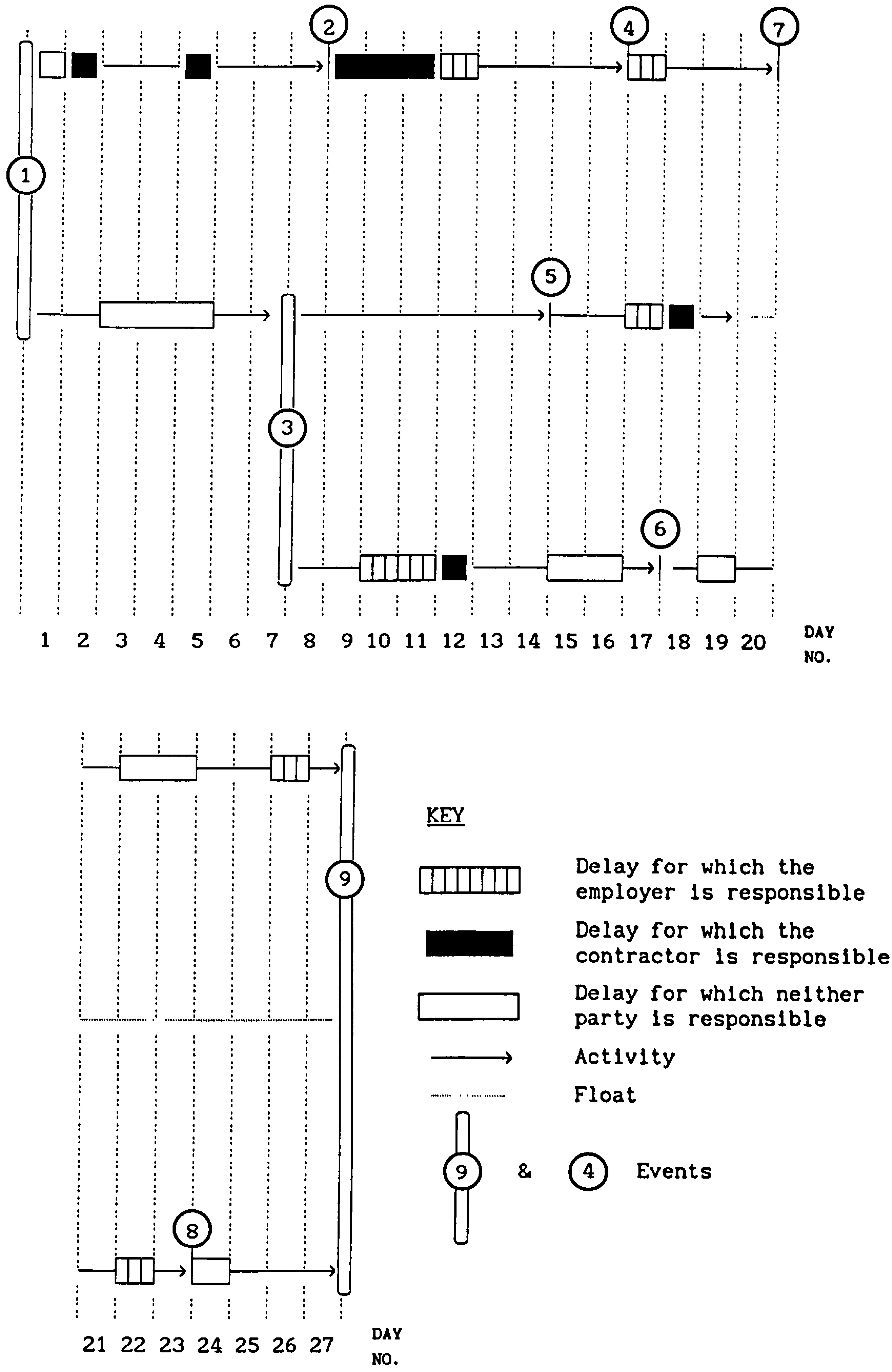
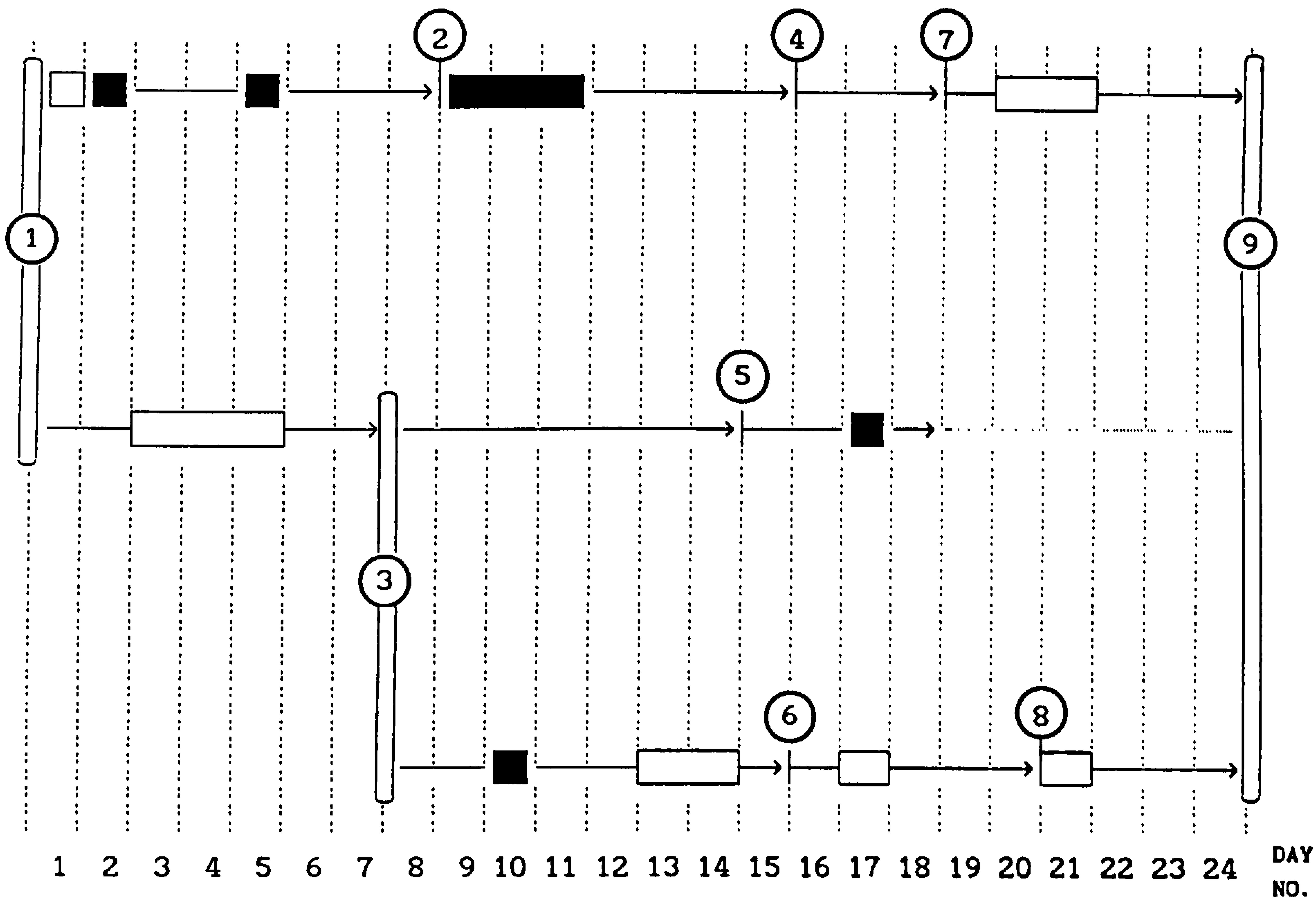


Figure 3.3 'As-built' CPM reflecting all delays



KEY

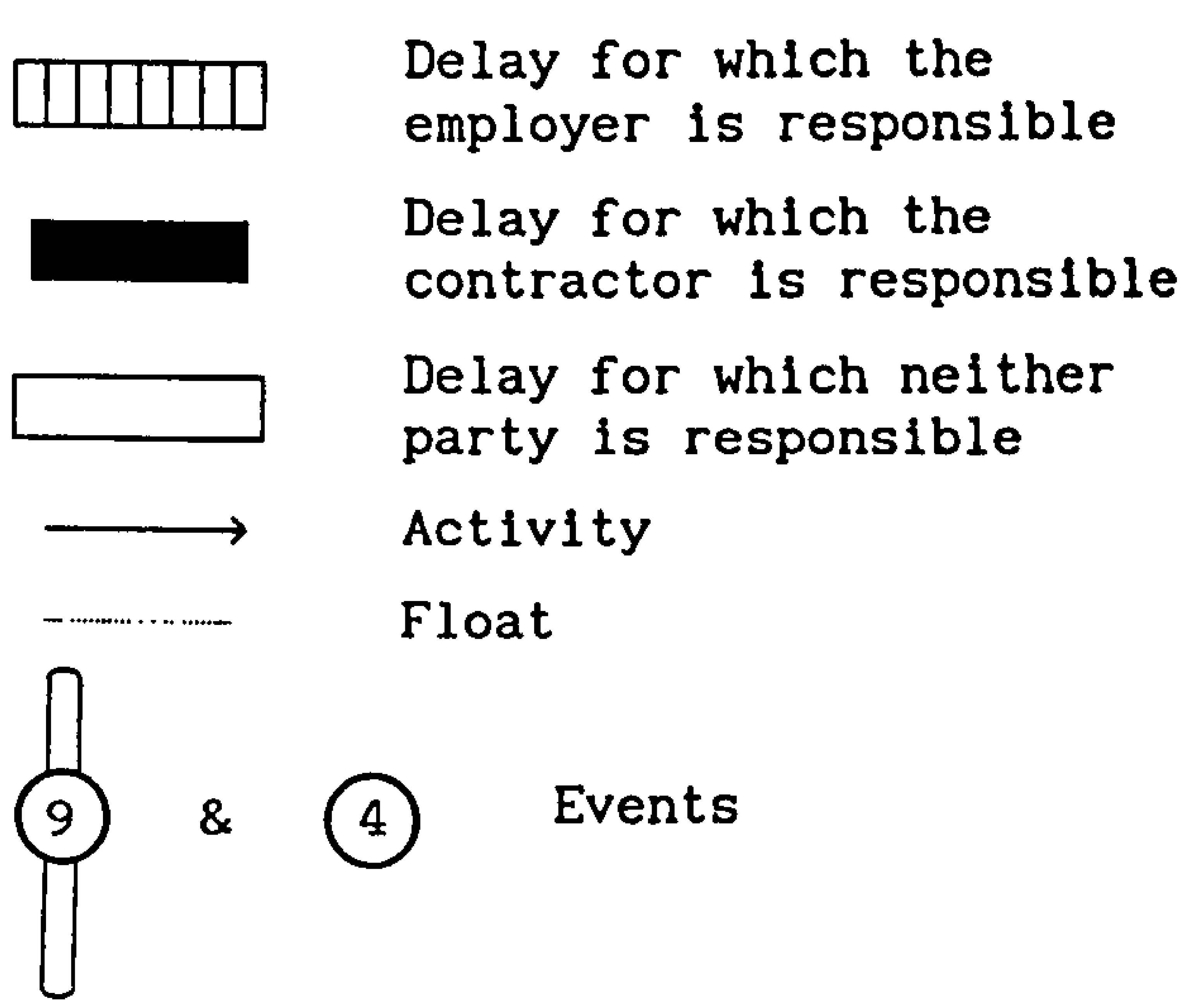


Figure 3.4 'Adjusted' CPM

Concurrent delay types	*Remedy*
Any delay concurrent with a type N delay(1)	Extension of time only
Concurrent delays type E and C (2)	(i) Extension of time OR (ii) Apportionment of liability

The remedies available when concurrent delays are due to the contractor and to the engineer are called by Kraiem & Diekmann the 'easy rule' (i) and the 'fair rule' (ii). Adopting the easy rule, an extension of time is allowed to the contractor with each party suffering its own losses. If the fair rule is to be used, some means of assigning culpability between the two parties must be established so that apportionment of liquidated damages may be undertaken.

The method then, is to assess for each day of the project whether more than one delay has occurred on parallel critical paths through the network. If so, the next step is to determine the combined effect for all such days in line with the remedies discussed. Having completed that exercise, the adjusted schedule may then be determined much as in the previous approach. Figure 3.5 represents the 'as-built' CPM for the network discussed in section 2. It is in fact the same as figure 3.3, except that this time

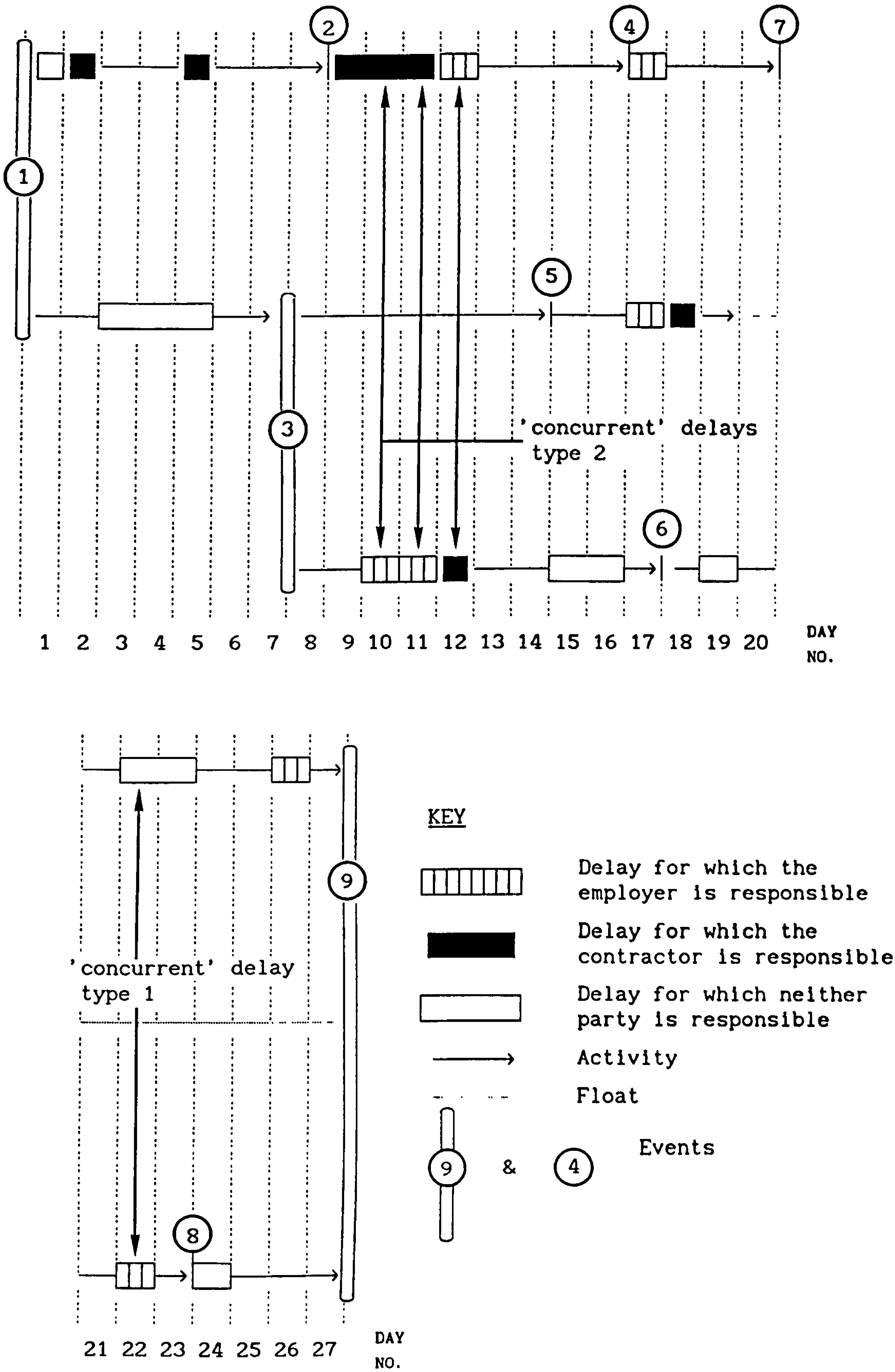


Figure 3.5 'As-built' CPM indicating 'concurrent' delays

the 'concurrent' delays have been identified and recognized as being of types (1) and (2) above. So, assuming that the 'easy rule' is to be employed such that the effect of both concurrent delay types (1) and (2) is the right to an extension of time, it can be seen that the schedule adjusted to remove type E delays will give a project time of 27 days. Here, the employer's responsibility is for 0 days delay to the whole project with costs, although there will clearly be an entitlement to an extension of time without costs.

Discussion of the methods

The ultimate aim of any method of dealing with these matters must surely be to provide a solution that can be universally applied and that will give a unique, just and practicable result in all situations. Such an aim may well be unrealistic. It may be that the only assistance that academics can give to practitioners dealing with these problems is to help to define the general principles to be applied as necessary in individual situations. However, it is clear that any method offered in this area should be tested to see how it copes with 'real-life' events and equally clear that any shortcomings need to be pointed out. The methods just described will now be considered in this way.

1. First cause defines liability

As has previously been intimated, the methods of dealing with concurrent delays in the U.K. appear to be less well advanced than those in the U.S.A.. It is also true that there is little in the way of legal precedent in the U.K. as to how these matters should be resolved. That being the case, it is perhaps easier to understand how different this approach is to others being considered in the U.S.A. The method clearly attempts simply to deal with the situation where a variety of delays occurring at different times, but with some degree of overlap, delay a single critical activity as shown in figure 3.6(a). The solution offered relies solely on which delay occurred first.

The justice of this way of doing things must surely be questioned, when apparently it would appear that the right to what could be a substantial claim may rest on the fact that one cause of delay began (say) a matter of hours before another such cause of delay. There are also likely to be problems with the practicability of this approach, in that it does not help provide a solution when causes of delay start at the same time. This is a common situation at the beginning of contracts. That having been said, however, there is perhaps some assistance in understanding the general problems of concurrent delays proffered, perhaps inadvertently, by this approach. A number of instances can easily be imagined where once one delay has

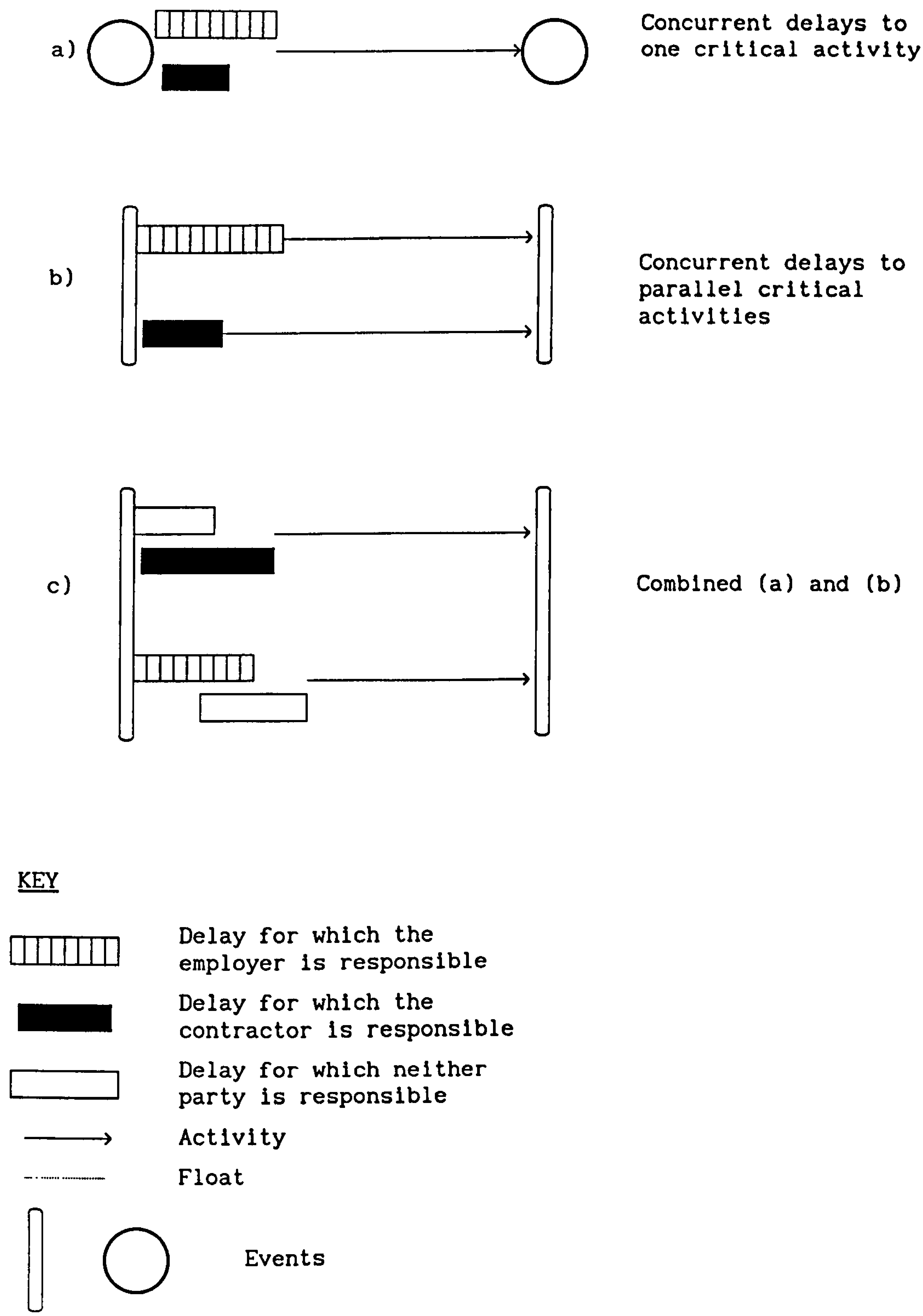


Figure 3.6 Types of concurrent delay

occurred to an activity, any subsequent delays attributable to other parties will not actually become apparent until the first delay has come to an end. For example, a contractor who is being prevented from starting an activity due to a particular part of the site not being available (type E delay), is unlikely to own up to the fact that he could not have started anyway (say) because he had not given sufficient notice to the suppliers of some essential materials required for that activity. The suggestion that stems from this argument is that some of the concurrent delay situations we can envisage by different combinations of the symbols adopted to represent delays and activity progress may seldom, if ever, occur in practice. Such situations may actually appear as a set of delays in series attributable to different parties with little or no overlap, much as the resultant solution given by this approach.

2. Adjusted CPM schedules

There is a powerful logic at the root of this approach to delay analysis, that is difficult to fault. The justice dispensed by a system that attempts to determine the time a contractor would have taken to complete a contract in the absence of employer-responsible delays and then to give additional time with costs for any extra time he had to remain on site as a result of those delays seems most reasonable. From the literature, it is clear that the procedure is not considered susceptible to mechanization. It is generally accepted that there will always need to be associated with this approach, a discussion and thorough back-up in the form of detailed site records.

As previously noted, concurrent delays are not typically mentioned in this approach, and yet concurrent delays on parallel critical paths (figure 3.6(b)) can clearly be handled. The issue of parallel critical paths in 'as-built' CPM diagrams will be discussed in the next section. What is not covered by this method, however, is an ability to deal with the problem of concurrent delays to a single critical activity as shown in figure 3.6(a). We can also easily imagine an instance where this is compounded by the same situation on a parallel critical path (figure 3.6(c)). It seems then, that the issue of concurrent delays cannot be totally avoided by this procedure. A system of dealing with the problem depicted by figures 3.6(a) and 3.6(c) needs to be combined into the overall approach. It may well be that this is an area where legal precedents will be helpful, and the guide-lines reproduced in the previous section might be appropriate here.

3. Date assessment of concurrence

This system is probably best seen as an additional stage added to the procedure described in section 2. Having arrived at the 'as-built' CPM for the project, the extra operation is to seek out and modify any concurrent delays. That is delays on the same date that are found on parallel critical paths. This completed, the adjusted CPM is then determined in the normal way. The justification for this approach is presumably that it has been accepted that concurrent delays are to be dealt with in a particular way. Yet, a number of difficulties can be envisaged in the carrying through of this procedure, and in the justice of solutions obtained, as:

i) To be able to apply this modification to concurrent delays, we need to be certain about when the relevant delays actually took place. This may be difficult to define or it may be that it is determined by chance, as the following examples indicate:

a) If a contractor takes longer to carry out an activity than he originally planned, does this necessarily constitute a contractor-responsible delay? If so, when can it be deemed to have taken place?

b) When additional work is added to an activity on the instruction of the engineer and this work causes a delay, it may be important to know whether the contractor did the extra work at the beginning, end or throughout the main activity.

ii) Concurrent delays are only to be modified if they occur on parallel 'critical' paths, and it is made clear that any non-critical path need not be considered. This is because it did not participate in the delaying of the project. The question arises whether it will ever be possible to know definitely that two paths through the network were actually of the same length. At the planning stage of CPM use, when activity durations are given as whole numbers of days, weeks or months, it is easy to determine parallel critical paths. In real-life, when each working day has 8 hours and each hour has 60 minutes, just how close do the durations of two paths through the network need to be before they can be considered as both critical? In the situation where the payment of large sums of money may rest on the answer to this question, the negotiations would no doubt be protracted. This highlights an important difference between CPM used for planning and the use of CPM in a claims situation. For planning, the time units adopted will always be integers, whereas in real-life, time is measured using real numbers.

iii) A blanket adoption of this procedure would appear likely to produce results that owe more to chance than they do to any semblance of justice. The situation can be imagined where, if parallel critical paths can be identified, one of these could contain only delays for which the contractor was responsible. This would mean that he could not have completed the contract any sooner, and yet 'concurrent' delays on a parallel critical path may give an extension of time and defray the option of deducting liquidated damages. On the other hand, concurrency of delays may have the effect of reducing the contractor's rights to an extension of time with costs in an instance where he could have completed earlier but for the employer-caused delays. This occurred in the example given.

These difficulties would seem to cast serious doubt on the value of this approach. Undoubtedly concurrent delays are an issue when they affect a single activity, but to look for concurrency on parallel critical paths may be stretching any legal precedent rather too far. Of course, the legal precedent referred to here is one that appears to be accepted in the U.S.. No such similar precedent has been uncovered in the U.K.. It was partly for this reason that questions on this area were included in the questionnaire used for interviewing U.K. engineers. Discussion of the results of those questions is to be found in chapter 5.

The nature of delays

In the analyses conducted so far, the only classification of delay type adopted has been by responsibility, viz. types E, C and N. It has also been assumed that the actual dates when such delays took place could be readily and uniquely determined. Whilst considering the particular problems of concurrent delay, however, some of these assumptions have been brought into question. In this section, the intention is to highlight the areas of uncertainty recognized and attempt to make recommendations as to how these difficulties may be overcome. If the methods of delay claims analysis require data on delays in a form that cannot be provided, it may be necessary to amend those procedures to enable data that can be produced to be handled.

Much of the difficulty seems to arise from the need to tie down each delay to particular dates so that the CPM approach can be adopted. It will be seen that some delays will take place on specific dates, irrespective of which activities are underway. Some delays will take place at particular points in the completion of an activity and some delays may be capable of leeway in when they have their effect. Each of the previously-recognized delay types will now be considered in turn in an attempt to identify any specific anomalies or discrepancies.

1. Contractor-responsible delays

To date, typical examples of this type of delay have been considered to be such matters as: inadequate supervision and technical support; late agreements with sub-contractors/suppliers and insufficient labour/plant. From factual networks used as examples in the literature, only Rubin et al (27) identify any contractor-responsible delays. These are: late start; repairs to the works and delay by the contractor in producing a drawing. The question arises whether any unhindered activity duration that takes longer than the duration quoted on the original contract programme should be considered as containing contractor-responsible delays.

If we recognize the contractual arrangement that exists on construction sites, then it must be clear that the contractor will not wish to appear as having any responsibility for delaying the works. This might well diminish his claim for loss as a result of other delays where time or preferably time and cost may be laid at the employer's door. With this in mind, it is considered that it may be quite difficult to pinpoint delays for which the contractor is responsible. Thus the problem of dealing with them in concurrent delay situations may well be a minor one. When the contractor has clearly used inadequate materials or produced work below the standard required by the specification, and must make amends by replacing or repairing, there will be little doubt that the delay caused is the contractor's responsibility. Such a delay would be readily fixed as to the date of occurrence and duration. In other circumstances, as it is the contractor who decides what activities will be shown on the contract programme, he is unlikely to show any activities that he needn't show. An example of such an activity would be his own production of falsework drawings, where there is a real possibility of late achievement.

Concerning late starts of activities being identified as type C delays; in the situation where only one or two activities were being undertaken on the site, such inactivity might well be noticed and commented on by the R.E.. On a reasonable-sized site, however, the confusion of activities underway, only roughly following the expected sequence of work may well hide the fact that an activity is not starting that might be started. In any case, the contractor may simply state that he has his own reasons for not pursuing a particular activity at a particular time and consider such matters to be none of the R.E.'s business. Provided the records show that there was no work and yet no delay, any subsequent analysis should not be affected.

The question raised earlier as to whether activity durations longer than those shown on the contractor's initial programme should be thought of as containing contractor-responsible delays has not yet been addressed. If we were to consider a 5 week activity on the contractor's initial programme that actually took 7 weeks to carry out as containing 2 weeks of type C delay, when exactly would we say that the delay had occurred? In fact, the effect of recording the 7 weeks for the activity on the factual network has a similar effect to recording 2 weeks of type C delay. The contractor in this case has approached 2 weeks closer to the time for completion whilst not gaining any advantage that he could use for a claim for extra time or costs. Perhaps then, where no particular reason can be established as creating the delay, it is sufficient simply to record the actual duration without any other comment.

In general, it would seem that delays due to the contractor may be hard to recognize. Perhaps it is only in those circumstances where the contractor's responsibility is undeniable that a type C delay needs to be recorded.

2. Employer-responsible delays

The typical employer-responsible delays are those due to changes to the contract documents, failure to provide land or information within a reasonable time and failure to approve the contractor's method of working expeditiously. This is reflected in the networks in the literature where failure to approve a reinforcement design, a design change and a suspension of the works are used as examples of this type of delay. It seems that such delays will typically be painfully evident in their effects on progress and, of course, there should be no attempt to cover up these effects. That is not to say that there may not be considerable discussion between the contractor and the R.E.

as to the exact extent of each of their liabilities.

The employer-responsible delay is probably the one with the most variety and it is easy to imagine the following types:

i) Delays that can affect a number of activities and are not specific to any particular one.

ii) Delays that must occur at a particular point in the completion of a specific activity.

iii) Delays where some flexibility exists as to when they have their effect.

The first type could result from a suspension order that might affect one activity, a number of activities or all activities depending on what particular aspect of the work had been suspended. An example would be the uncovering of an uncharted gas main in an excavation. This might lead to a need to plan and implement a services diversion that clearly could not have been known about at tender stage. This would typically require that other work in the area would have to be stopped and could not resume until the diversion was complete.

An example of the second type would be failure to approve falsework drawings in time, in which case the contractor's erection of the temporary works would have to be delayed.

This delay could be seen as taking place at the beginning of the erection activity. We can also imagine another situation in which specific additional work was instructed that clearly added to the workload of an existing activity in the contract programme, and that had to be carried out at a particular stage in that activity. For example, an instruction to increase the reinforcement in a reinforced concrete member would usually involve some delay at a particular point in the activity of fixing reinforcement in that member.

It is believed that many instructions to carry out additional work will not involve delays being enforced at a specific time or at a definite stage in the completion of an activity. Some variations will require the contractor to carry out work that is unlike any other work in the contract. In these circumstances he will be expected to reschedule to accommodate the new task with minimum disruption. Even where similar work exists in the contract it may not be essential that the extra quantity is carried out at the same time as the similar contract work. If it is implemented during the same period, it may well be possible for the instructed task to be performed at any time during that period with no detriment. For these unaffiliated delays, to record them as occurring at a particular time and then to process them along with other more fixed concurrent delays may be unreasonable. It seems that such delays should be annotated to record that they might have taken place at another time.

3. Delays due to neither party

Under the JCT form of contract, these delays are well documented and consist of: exceptionally adverse weather conditions; civil commotion; strike or lock-out; local combination of workmen, and force majeure. This last term is used to mean events completely unpredictable by the parties prior to making their agreement and that affect progress. ICE5 does not spell out what is to be considered under this heading anything like as clearly, referring specifically only to exceptionally adverse weather conditions. There is, however, the opportunity for the engineer to accept that 'other special circumstances of any kind whatsoever' have delayed the works and to award an extension of time if he believes that to be deserved. In examples in the literature, it is the strike that has been adopted to represent this type of delay.

Undoubtedly, certain type N delays will arise on specific activities. A local strike on the site might easily result if the bonuses to be earnt on a task are seen by the workforce as unfair or if output targets to be achieved in order to earn bonus are considered unattainable. In many circumstances though, the delay will take place irrespective of whether a contract exists or not. The weather is totally independent of how many contracts are underway and a national strike of a particular part of the workforce will not generally be directly influenced by a specific contract. It will, however, clearly affect all contracts underway at the time. The fixing of these delays in time should not, on the face of it, cause any special problems as they are not usually susceptible to manipulation. Neither should it be especially difficult to identify quite which activities have been affected. These statements are believed to be true of most of this type of delay, but the problems associated with weather delays are felt to be significantly different.

Defining exactly which days of a project were lost due to adverse weather conditions should not create too many problems. The difficulties arise when we realize that not all days lost due to weather are accepted as generating a possible extension of time. It is 'exceptional' adverse weather that must be identified for this purpose. The recommendations in the literature are that to assess if the weather has been exceptionally adverse, the engineer will have to look at the weather for the project as a whole. If the weather in the area concerned is generally better than the project weather, then presumably the engineer will use his assessment of the average weather to calculate a number of days of delay for the project. No specific procedure has been found as to exactly how to do this, but the following is suggested as a possibility:

i) For the contract under consideration, look at the weather conditions that occurred on the site on days when work did not take place and note them.

ii) From the above data, attempt to identify the one particular weather parameter of wind, rain, temperature etc., that resulted in an inability for work to take place.

iii) Search past weather records over a number of years for identical parameters to those that have been found to cause work to stop and make a record of each such day.

iv) From the above information calculate an average number of days that could be expected to be lost on construction work per year.

v) Compare actual days lost over the construction period to the average. If there is a marked difference between summer and winter (as might be expected), it may be necessary to attempt to identify average weather over a shorter period than a year. This would lead to a simulation of average weather over the particular months or seasons in which the contract was working.

vi) From the comparison of average weather and actual weather experienced during the contract, any assessment of exceptional adverse conditions could be deduced and a number of days delay calculated.

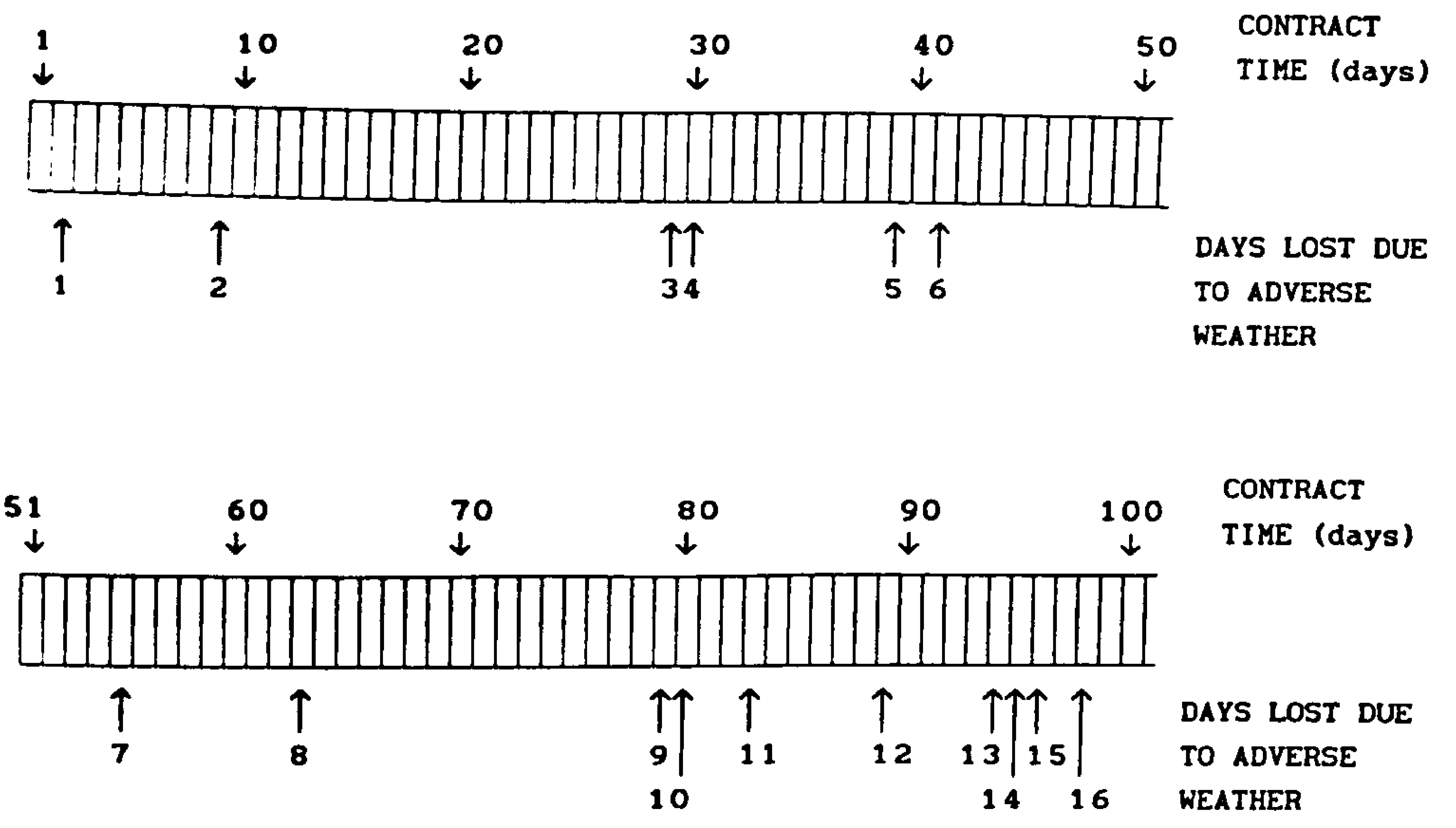
Such an approach is clearly flawed for the following reasons:

i) It assumes that one parameter alone will always be responsible for work stopping when it may be that a combination of factors, each at a lower level than the individual factors, will sometimes have the same effect.

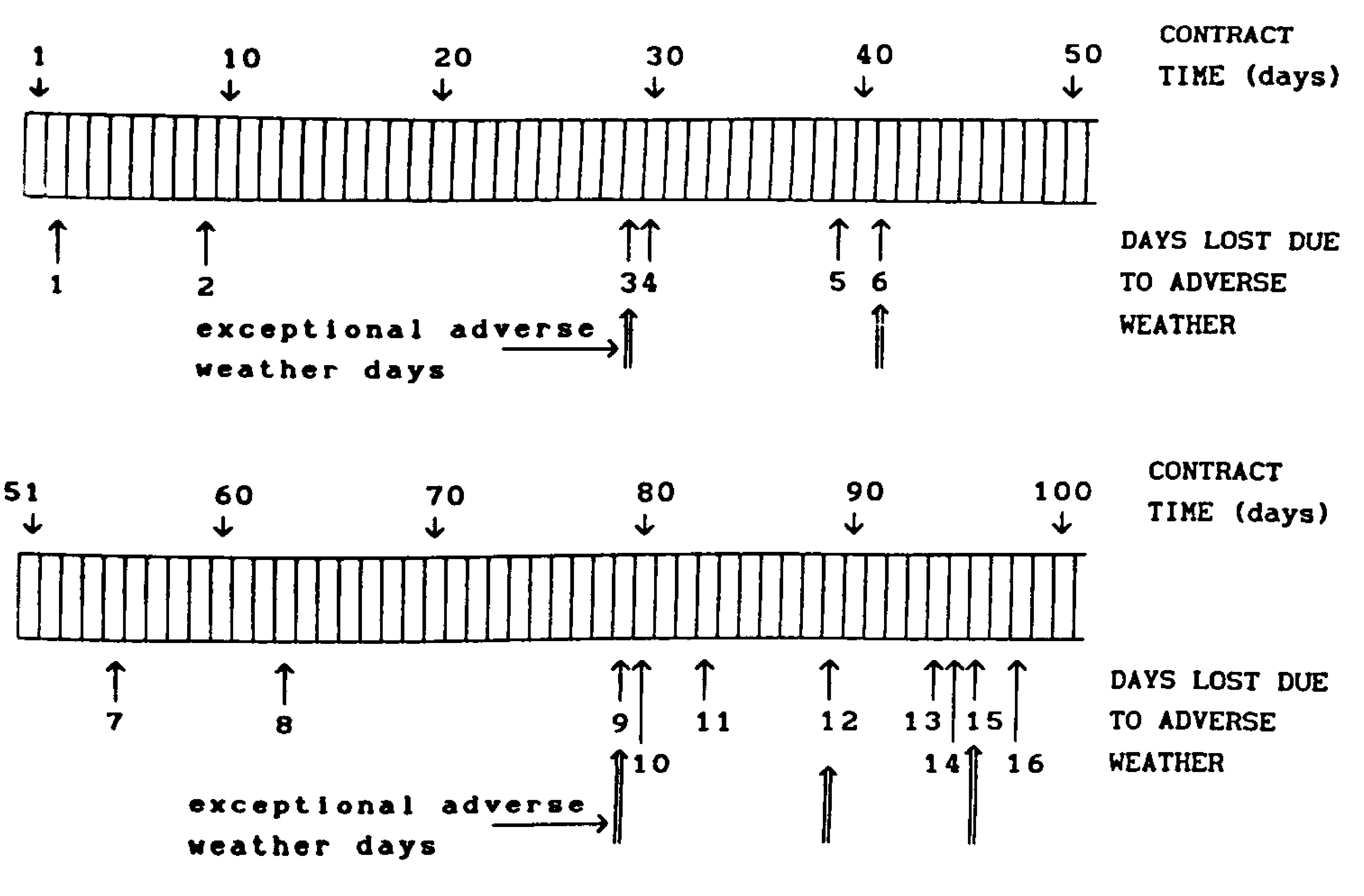
ii) The possibility that certain weather conditions will affect some activities and not others has not been incorporated.

However, it is believed that this approach is as good as if not better than the analysis carried out on most sites. At the end of such an analysis, we will be left with either an awareness that the contract weather was no worse than could have been expected or that it was worse, and that an allowance of a number of days delay can be justified. In the latter event, the problem still exists as to exactly which of the days lost should be considered as exceptional and which to be expected.

Figure 3.7 demonstrates the difficulty in a simplified



a) Days lost due to adverse weather



b) Selection of days of exceptional adverse weather

Figure 3.7 Identifying days lost due to adverse weather representation of the problem. The actual days lost to the project as a whole as a result of weather are shown in section (a), and we can see that in the 100 day project, there were 16 days in which work could not progress. If our assessment of average conditions leads us to believe that 11 days lost due to adverse weather could have been expected, then presumably 5 days of exceptional adverse weather will be admitted. In a total cost approach, this information might well be adequate, but when using CPM, we need some method of deciding which 5 of the 16 days should be considered as exceptional. Any method adopted to identify these 5 days must surely be seen as in some respects artificial, in that the particular days pinpointed will depend on the approach that is implemented. It is suggested that any solution should embody the following principles:

i) The days selected must be actual days when work was in fact stopped on the site.

ii) The spread of exceptional delays throughout the contract should follow the general pattern of total days lost due to weather.

iii) The method should be standardized and unaffected by the individual contract.

With these principles in mind, it is proposed that the following be adopted:

Starting with the first day lost numbered 1 and subsequent days numbered in order as figure 3.7(a), exceptional days are to be selected as occurring every n^{th} day lost, where n is given by:

$$n = \text{INT}\left[\frac{\text{Total days lost}}{\text{Exceptional days}}\right]$$

....thus, in the example:

$$n = \text{INT}\left[\frac{16}{5}\right] \quad = \text{INT} \; (\; 3.2 \;) \quad = 3$$

Part (b) of figure 3.7 shows the result that stems from this procedure. A quite different result would, of course, have been obtained if exceptional delays had been selected starting from the end of the project and working towards the beginning. However, it has already been accepted that the method of selection must to some extent be a compromise. It is suggested that the recommendation above is a reasonable compromise in the circumstances.

In general, it seems that for delays for which neither party is responsible, the duration of these delays and their impact on the contract should be straightforward. The same cannot be said for delays due to adverse weather, and to incorporate such delays into a CPM-type analysis, a procedure for selection of exceptional delays will need to be adopted.

Looking beyond the limitations of delays as categorized by responsibility, two other aspects of delays need to be considered. The first is to recognize that not all delays will bring activities to a complete halt and that in some circumstances work may be possible, albeit at a reduced level of output. Where this occurs, and it would be most likely to occur with delays type E, Hughes (6) suggests converting the retardation into a period when work was 'as if' stopped. This done, it could then be treated like any other delay. Of course, there would be no special reason for scheduling such a delay at any particular time and it is suggested that this fact should be made clear by annotation; much like the type E delays discussed earlier.

The second point to note is that it is possible for some delays to have an impact beyond their own durations. This can occur where a weather window is missed as a result of a delay and in such a situation, the delay to the project can be many times greater than the delay that caused it. Where this has occurred, it will be important that the responsibility for such a consequence is clearly defined and recorded.

Combinations of delays

From the previous section, a number of views regarding the nature of delays have been put forward. These will be summarised here, as:

1. Type C delays may well be difficult to identify except in specific circumstances. Providing a factual network approach is adopted that shows when work was proceeding and when it was not, this should be sufficient.

2. Type E delays: in some situations, these delays may not be uniquely fixed in time (unaffiliated), and where this is true, the particular delays should be annotated to indicate this.

3. Type N delays should generally be easy to identify and schedule, except for delays due to exceptional adverse weather, which will have to be artificially selected from days lost on the contract.

When discussing the 'adjusted CPM schedules' approach to dealing with concurrent delays, it was suggested that such an approach was generally seen to be the most logical and the one most likely to produce a 'just' outcome. Concurrent delays to a single activity, however, are not dealt with by this method and it was realized that such an ability would have to be built in to overcome this deficiency. Unlike the procedure intimated by the current definition of concurrent delays though, which states that these need only be considered where they would have affected the ultimate completion date, it is believed that all concurrent delay situations as represented by figure 3.6(a) should be analysed. That is to say that we should look at all concurrent delays as figure 3.6(a) in the contract, whether they are on a critical path or not. The justification for this is shown in figure 3.8, where it can be seen that the concurrent delays on a non-critical path must be resolved before an adjusted CPM schedule (absent employer-responsible delays) can be devised.

In simple terms, the problem of concurrency on parallel paths in the network (figure 3.6(b)) can be dealt with by the 'adjusted CPM approach': overlapping delays to a single activity (figures 3.6(a) & 3.6(c)) cannot. Here, we must find some means of converting the overlapping delays into delays in series so that the adjusted CPM approach may then be adopted. It may be that the only way to achieve a solution here is to define, either by legal precedent or, as this seems unlikely, by specifying how such matters are to be resolved in the contract documents. Before any such ruling was adopted, however, it is suggested that the facts of a particular case, together with the additional understanding of the nature of delays just summarised, may allow sensible decisions to be made without any recourse to general principles. Two examples of instances where the

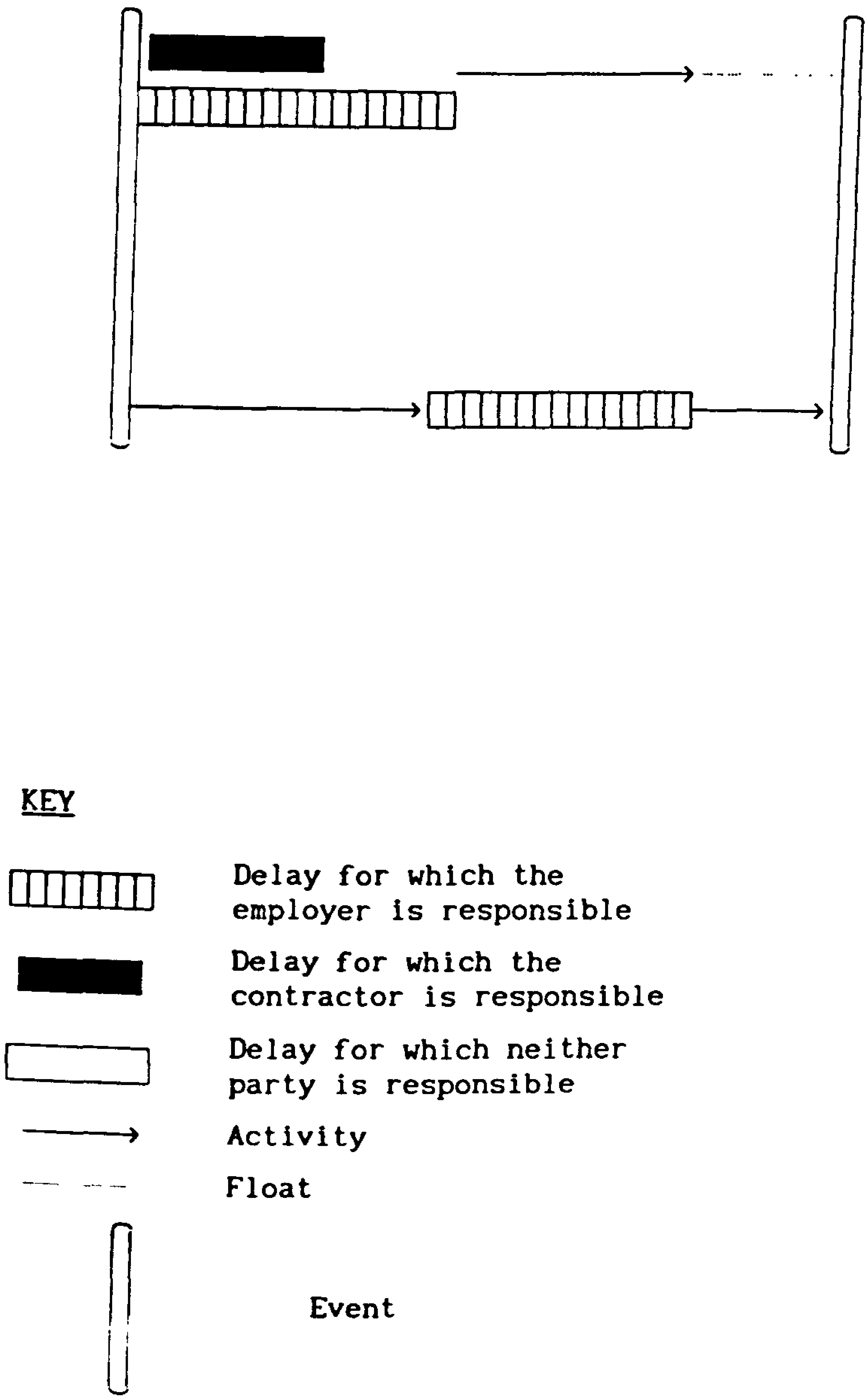


Figure 3.8 Diagram to demonstrate the need to deal with concurrent delays on non-critical paths

particular may override the general are given below:

i) Where delays are concurrent only because an unaffiliated delay has been scheduled at a particular time, this may well affect the solution proposed.

ii) If the overlapping delays are of type E and N (probably the most frequent combination), it will be important whether the delay type E involves additional work or not. If additional work is involved, then this presumably would have to stop when the type N delay comes into force. There would thus be no actual overlapping of delays to reconcile. If, on the other hand, the type E delay is simply a period when no work is possible, then an overlapping delay situation would exist that needed to be resolved.

The definition of concurrent delays quoted near the start of this chapter has been questioned. In the light of the subsequent analysis and discussion, it is felt that a better definition would be:

Concurrent delays are two or more delays that both occur at the same time and that affect an individual activity. Where this occurs, whether on a critical path or not, it will be important that this overlapping delay situation is resolved to a series of delays to allow the adjusted CPM schedule to be identified.

CHAPTER 4

DEVELOPMENT OF THE QUESTIONNAIRE AND CONDUCTING THE INTERVIEWS

To an engineer, who has been trained principally in scientific methods of investigation and analysis, the use of questionnaires does not have any easy appeal. This is particularly true when it is clear from the outset that a good deal of the information that is collected by this process may not readily lend itself to mathematical analysis. How much easier and how much safer it would seem, to be carrying out laboratory work in order to produce data that is immediately susceptible to manipulation. Instead of this, the investigation must depend upon eliciting responses to questions that are believed to be important, and yet that are difficult to phrase in a clear and unambiguous way. It is, however, the particular nature of the research area under investigation and of the information sought, that traditional scientific approaches cannot be adopted. What other way can sensibly be used to identify how engineers and others in various construction-related organizations deal with particular problems and to make recommendations as to how they should deal with them?

The desire to deal only with easily quantifiable data has already been mentioned. This propensity is one that can be understood if the traditional methods of educating engineers are recognized, where so much of the curriculum is based on the correct manipulation of numbers. Although it is clearly essential that engineers are numerate and perhaps even that they have a bias towards mathematical solutions, there is also a need for the ability to deal with more qualitative data. Many of the problems encountered by an engineer working in the industry do not lend themselves to mathematical solutions. This is particularly true in the area of management, but also in other areas. For example, when comparing alternative schemes at the feasibility stage of a project, many factors must be considered. The way in which each individual factor is affected by each scheme must be the basis for selection of the optimum scheme. In this common scenario, it is seldom possible to support such a selection purely on the basis of mathematics involving a simple weighting of the various parameters. It is true that mathematics will have played an essential part in producing the data on which the decision is to be made. Nevertheless, the final decision cannot be left solely to an examination of the numbers; a degree of judgement must also be applied. Judgement is also important on construction sites, where a certain level of technical ability is required to carry out the day-to-day business of the organization effectively. It is, however, the engineers who are able to use common sense, relate to past experience and make sensible decisions where information may be scarce, who are likely to advance in their careers.

The method of investigation using questionnaires clearly falls short of traditional scientific procedures. This, however, must not be seen as an excuse for poor work and it is essential that the method is adopted with as much scientific rigour as possible. This is likely to manifest itself in a number of ways, viz.:

i) ensuring that the most pertinent questions are included in the questionnaire and that, where possible, the method of analysis has been defined before the data collection begins;

ii) good design of the questionnaire, in terms of the ordering of the questions and the method of questioning;

iii) careful wording of the questions to ensure, as far as possible, that no ambiguity occurs;

iv) accurate recording and orderly classification of the responses;

v) logical analysis of the results.

To comply with point (i) above, the reasons for collecting the data, together with the uses to which the data will be put, must be clearly understood. These are the matters that will be considered in the remaining part of this opening section.

As has been mentioned in the main introduction to the thesis, the way in which contract programmes are requested, checked and subsequently used has received little coverage in the U.K. literature. Here then is an important reason for collecting data in this area: to add to our knowledge of contract procedures and to recommend good practice where it can be identified. What does get recorded in the literature is a clear awareness of the problems that delays and disruptions cause to construction projects. It is with a belief that this source of aggravation and frustration may be relieved to some extent by proper use of these programmes, from which the wish to recommend sensible procedures stems. If good practice can be defined and publicized, then less acrimony may result.

To view construction without recognizing the basic confrontational nature of construction contracts is to miss an important element of the scene. On site, there are two parties with interests that can be conflicting. With regard to claims, the engineer is expected to behave in an impartial manner, whilst the contractor must surely be aiming to maximize his returns. Such an environment makes it difficult for basic ground rules to be laid down to govern those particular situations that keep recurring in claims. This means that little new is learnt concerning how to deal with these complex problems. Contractors will not learn how best to prepare their claims and engineers will not develop their methods of analysis. If it can be verified that on some aspects of these problems the two sides are in agreement, this at least might reduce the areas of conflict. Although different questionnaires were used for contractors and engineers, most of the questions asked were common, allowing the responses of contractors and engineers to be compared. Thus, another use of the interview data can be recognized.

The considerable gulf that has been identified in chapters 1 & 2 between the way in which these matters have been approached in the U.S. compared to the U.K. begs the question why this should be. Why has a detailed procedure been recognized and refined in the U.S. for dealing with delay claims and is there an accepted, though as yet unpublicized, system being used in the U.K.? The problem clearly has to be dealt with on both sides of the Atlantic and engineers in the U.K. are obviously making decisions in this area. How do they do this when there is so little by way of assistance to help them with these complex matters?

These then constitute the principal reasons for collecting data. The particular method of collection will now be discussed.

Selection of the survey method

While admitting of numerous methods of data collection, Oppenheim (39) identifies two main approaches. These are:

i) interviews conducted on the basis of a structured questionnaire;

ii) questionnaires distributed by mail.

Gardner (40) adds another method to the above that he calls the informal interview. Unlike (i), this is conducted without a structured questionnaire and simply relies on a list of topics to be covered, that are raised at appropriate moments in the interview. It is these three methods of investigation that were considered as possible options for the current study.

In considering the first two methods, Oppenheim recognizes both as having certain advantages that will make them preferable in different situations. The interview using a structured questionnaire is seen to have greater flexibility than the mailshot. This is because during the interview, the interviewer can make sure that the respondent has understood the question. There is no opportunity for such a confirmation in the mailshot approach, which means that for this second method, the questions typically have to be simpler.

The interview method is considered to be fraught with possibilities of bias, in that the interviewer can easily give an impression of his/her views by a change in the tone of voice or other subtle means. No such influence can be brought to bear with a mailed questionnaire, and it is certainly true that this method is cheaper and therefore allows a greater coverage to be achieved. If simple questions are to be put to a wide audience, this would appear to be the best way to do it. It must be recognized, however, that response rates will typically not be good. Also, if it is essential that the questions are answered in a particular order, as is true of some questionnaires, then this condition cannot be enforced by this means. Interviews would have to be conducted.

The main advantage claimed for the informal interview is that it can leave the direction of the discussion in the hands of the subject without much guidance from the interviewer. This can be a useful way of determining what the respondent considers to be important without imposing any attitudes that a specific choice of questions necessarily embodies. There are problems, however. The process can be very time consuming, typically involving the use of a tape recorder, and it is possible that the topic most central to the research project may never be reached. It is for this reason that a 'gently guided' approach is often used in place of the totally unstructured procedure. Here, the interviewee is lead through the area of concern by the interviewer changing the direction of the discussion to matters more relevant as the opportunity arises.

The decision to collect the data for this project using interviews based on a structured questionnaire was made for the following reasons:

i) The areas of concern were felt to be too complex and too difficult to explain, for them to be well received simply as bald statements on the printed page. The need for additional explanation to ensure that the respondent had fully understood the question seemed likely. This ruled out the mailshot approach.

ii) The choice between formal or informal methods of interviewing was not so straightforward. It seemed that using informal methods might cause the important issues to be uncovered, but that the data collected by this approach would be difficult to analyse. Use of the formal approach would require that the important questions were decided before the survey began. As the opportunity had been arranged to be associated with a site where it was felt that the source of the relevant material could be tapped, a decision was made to opt for the formal interview technique.

The process of attempting to identify the most interesting areas and the most relevant questions is dealt with in the next section.

Defining the questions

It is not possible to wish to open up an area for research without having some ideas as to the kind of questions one would like to see answered. There is, however, a considerable difference between having a general idea as to the areas to be covered and defining the questions specifically to the word! Very early in the process it was realized that some piloting of the questionnaire before the main survey would be a good idea. Whilst aware that this part of the study would probably identify the worst gaffes in the questionnaire, it was firmly believed that it would not transform it. Poor questions on areas of secondary interest would not, thereby, be changed into good questions on the most important areas. It was imperative then that some means was found to ensure that the most useful and relevant parts of the subject area were covered in the survey.

An arrangement was made to have access to two major construction sites, which were road and bridgeworks contracts, in the local area. This was done so that particular examples of contract programmes and the way in which they were dealt with could be studied. The hope was clearly that this would provide the understanding necessary to define these important areas. Regular visits were made to these sites during a period from September 1987 to February 1988 with 18 visits being made in all. During these times, a number of different activities were undertaken. These were:

i) examining the Clause 14 programmes to see how well they represented the work of the contract;

ii) reading the correspondence on the approval of the programme and progress generally;

iii) trying to build up a CPM network from the bar chart format adopted for the Clause 14 programme;

iv) attempting to produce a 'factual network' from the R.E.'s records;

v) walking the site and trying to record progress in terms of the contractor's activities;

vi) keeping a diary of personal activities whilst carrying out the above and recording important thoughts as they arose.

This was a formative period in developing the ideas that have come together in this work. It was from this starting point that the decision to write a computer program for keeping records, reported in chapter 9 stemmed. In the early stages, new ideas and impressions were arising on each visit to the site. This later tailed off but the visits were continued for as long as it was felt that something might be gained from the process. On reading generally about the business of collecting data by surveys following this period, a book by Douglas (41) was found that contains passages that seemed to mirror the procedure adopted. Douglas is interested in collecting information about the sex-lives of his interviewees, and recommends a process that he calls 'immersion' for identifying the important aspects of an area of research. He sees this as a means of approaching the truth by 'de-focusing' - not thinking about the bigger meanings of things until we have experienced them directly. He also suggests that you should '..keep going with your explorations until you stop hitting "pay-dirt" - that is new truths about the phenomenon you are studying'. Although from an unlikely source, this reference seems to give some support to the method adopted for the current study.

Having finally made the decision that no more 'pay-dirt' was likely to be revealed, the process of writing the questionnaire began. It soon became clear that two questionnaires would be needed; one for interviewing the engineer/resident engineer and one for interviewing the contractor's agent/quantity surveyor. A number of revisions of these two documents took place before the final versions were ready to be tested by conducting the pilot interviews: the subject of a later section of this chapter.

The survey sample

The first step in making decisions about who to approach with the questionnaire required that the potential population who could be approached be recognized. Essential requirements were seen to be:

i) organizations involved in medium to large-scale civil engineering projects - it was felt that the problems being investigated would probably not manifest themselves fully on small projects;

ii) organizations fulfilling the roles of either engineer or contractor as understood in ICE5.

The main organizations complying with the above are, of course, civil engineering consultants, civil engineering contractors and the larger local authorities. While it was recognized that within any organization there may be a number of individuals acting as engineers or agents, it was not thought reasonable to request permission to interview more than one such individual from each organization contacted. However, in the belief that these matters may be dealt with by both engineer and resident engineer on the one hand, and agent and quantity surveyor on the other, it was decided to request access to one member of each type in each establishment approached. Thus an approach to a contracting firm would request that both an agent and a quantity surveyor were made available for interview.

For the pilot interviews, it seemed sensible to approach one contractor, one consultant and one local authority. However, for the main interviewing sessions, decisions were necessary with regard to the numbers of each type of organization to be approached and exactly which ones to choose. The main factors taken into account in this selection process were:

i) Logistics: from experience gained during the pilot stage, each interview could take between $1^1/_2$ - 2 hours to complete. If each organization was to provide two interviewees, this would typically take up most of a day with travelling time.

ii) Travel time and costs: in order to keep these to a sensible level, only firms operating within a 60 mile radius were considered.

iii) Type of work: in case the type of work undertaken affects the way in which these problems are dealt with, a range of work types should be surveyed.

iv) Response: the number of organizations approached in the first instance should be decided in the light of the likely percentage of positive responses.

From experience in carrying out the pilot interviews, it seemed that quite a good response could be expected. It was thus decided to approach 15 consultants, 15 contractors and the 3 nearest large local authorities, with a view to pursuing them if they did not respond to the first request. This was to be additional to the interviews carried out during the pilot stage. Of course, for reasons of confidentiality, the names of the organizations contributing to the study cannot be disclosed. The method of selection, however, can be stated and was as follows:

1. Consultants

From the NCE Consultant's File (42), which includes details of all British firms with 20 or more staff, a first 'sort' was made to eliminate all those who did not work in the North. This resulted in a list of 131 possible firms. A second 'sort' to weed out all firms who did not have a northern office left only 20 firms categorized as:

Category	*No of staff*	*No of firms*
1	500+	6
2	100 - 500	12
3	20 - 100	2

From these, all the category 1 firms, one of the category 3 firms and 8 of the category 2 firms were selected to be approached for the main survey.

2. Contractors

Starting from the NCE Contractor's File (43), which lists 100 main building and civil engineering contractors, the first 'sort' was to eliminate those contractors who did not work in the North. This produced a short-list of 49 firms. Some of these were specialist contractors or worked principally in building and a second 'sort' was carried out to eliminate these. This gave 34 contractors still on the list, distributed as:

Category	*No of staff*	*No of firms*
1	1000+	22
2	200 - 1000	8
3	< 200	4

As it was intended to interview these contractors on their sites, the next task was to find out which of these firms currently had a construction site in the northern area. By telephoning each contractor in turn it was possible to pick a group of 15 contractors who fulfilled all earlier requirements and also had a reasonably close civil engineering site. This constituted the list of contracting companies to be approached for the study.

3. Local Authorities

Here, no real selection was necessary: the authorities to be approached were the three principal local authorities in the area. This was additional to the authority that took part in the pilot study.

Having chosen the organisations who were to be asked if they would be willing to be involved in the study, standard letters were sent out. These were to make the first contact, to identify the aims of the research and to make the necessary request for assistance. Copies of these letters and of the follow up letters to those firms who did not reply to the first letter are included in Appendix 1.

Pilot interviews

Although a good deal of time and effort was put into preparing the initial questionnaires, it was still realized that they may not be as clear or obvious in their intent as might be hoped. The particular area covered by the questionnaires is undoubtedly a complex one and thus there was every chance that the wording of at least some of the questions might be difficult for the respondents to understand. There is also the problem in designing any questionnaire, that the likely responses must in some cases be anticipated by the designer so that the layout of the questionnaire may be established. In such an area as the one studied, it was accepted that these assumptions about how the questions would be answered may well be misguided.

This having been said, it was thought wise to carry out an initial pilot study consisting of interviews conducted with consulting engineer's staff, contractor's staff and local authority staff. These took place between July 1988 and January 1989. In all such data collection exercises, the researcher is dependent on the goodwill of the intended interviewees. Fortunately, it was possible to carry out interviews with each of the types of organization approached. The changes that this initial study indicated as necessary in each of the questionnaires will now be discussed. Copies of the original questions used in the pilot interviews which were subsequently amended are to be found in Appendix 5. The final version of the questionnaires used for the main survey is contained in Appendices 2 and 3.

1. Engineer's questionnaire

A number of revisions were made as a result of the pilot study, involving deleting questions, adding questions or rewriting questions. It was also considered necessary to include a few initial points to be made to interviewees prior to starting the interview.

NB Question numbers with a suffix 'm' refer to the pilot questionnaire numbers, otherwise numbers refer to the main survey questionnaire.

DELETIONS

i) Question 10m, which was initially incorporated to assess how important the respondents considered various aspects of the checking of the contract programme, was removed. In all interviews conducted, interviewees reported that they were very concerned about all the aspects defined. The question thus had no purpose.

ADDITIONS

i) The deletion of question 10m meant that no mention of the contractor's resources was included in the questionnaire. Question 15A was thus added to pick up such information.

ii) Question 17A was added in an attempt to ascertain the relative importance of various aspects of the programme.

iii) Question 20 specifies a particular situation in which the respondent is asked to recommend what the contractor should do when he has been delayed, but not beyond the original time for completion. This question effectively deals with a possible anomaly and helps to set the scene for the section on claims.

iv) Question 36A is a new question trying to identify the documentation that is kept with regard to decisions on extension of time claims.

v) In the belief that Clause 14 of ICE5 may not be providing the best starting point for requesting the contract programme, question 43A was included to determine the respondents' views.

vi) As the procedure for revising the contract programme had not been covered, question 43B was included to obtain information regarding the frequency of such revisions.

vii) It was recognized during the pilot stage that certain general statements needed to be made before the interview began. These were also to serve as an introduction and to clarify the purpose of the exercise. They are described and discussed in the next section of this chapter.

AMENDMENTS

i) A number of questions simply had their wording altered to remove possible ambiguities. These were: questions

24m, 27m and 28m - 31m inclusive.

ii) Question 13m was found to be confusing to the respondents and was thus tightened up in the revised version (question 12).

iii) A major amendment was necessary to question 23m which asked for details concerning the frequency of granting extension of time claims. This question had not been well thought out in the first instance and was completely reorganized in the revised version. This resulted in the incorporation of two questions, 23 & 23A, to cover the same ground in a more easily accessible way.

iv) It soon became evident that question 44m in its original form was, in fact, a 'trick' question. It relates to the importance of the initial critical path and would be answered differently depending on whether the respondent realized that this path could change as the project progressed. This was replaced with questions 44 & 44A which also refer to the critical path but without the contrivance of the original version.

2. Contractor's questionnaire

The changes to the contractor's questionnaire are very similar to those made to the engineer's, although question numbers are not common between the two.

NB Question numbers with a suffix 'm' refer to the pilot questionnaire numbers, otherwise numbers refer to the main survey questionnaire.

ADDITIONS

i) Question 13A, which is identical to the engineer's question 20, was added for the same reasons.

ii) The general statements incorporated at the beginning of the engineer's questionnaire were included, word for word, in the contractor's questionnnaire.

AMENDMENTS

i) Changes to the wording were found necessary in questions 9m, 12m, 13m, 17m, 20m and 21m - 24m, to avoid ambiguity.

ii) Question 16m was replaced with questions 16 & 16A in the revised questionnaire. This question is equivalent to question 23m in the engineer's questionnaire and was revised for the same reasons.

iii) As with question 44m in the engineer's questionnaire, question 36m was replaced by questions 36 & 36A.

All the above changes stemmed from the experience of carrying out pilot interviews and most of the additional question areas had been suggested by the respondents themselves. The resulting questionnaires were considered to be rather long, but in spite of this, it was felt that no more of the questions could be deleted. The next stage was to carry out the main survey interviews with the revised questionnaire.

The Main Survey

All organizations who did not respond to the first letter asking for assistance were sent reminders (see Appendix 1) after a period of time had elapsed. In the event, a total of 10 interviews were conducted with contractors (4 agent, 6 QS), 8 interviews were conducted with consultants (6 engineer, 2 RE) and 1 interview was conducted with a local authority. No response at all was received from a number of organizations contacted; even after the follow-up letters had been sent. One firm replied saying that they had no relevant staff available and another refused to become involved due to their policy of 'not discussing commercial matters outside our own organization.'

The companies and authority who were willing to contribute, did so enthusiastically and the interviewees seemed generally to find the experience interesting and stimulating. As has been mentioned, it became clear during the pilot study that certain points needed to be made to the interviewees before the questioning began. This helped to get the meeting off to a uniform start and also helped to avoid any uneasiness during the interview proper. These points, that are relevant to the general conduct of the interviews will now be discussed.

i) Interviewees were asked to answer all the questions even though they may not consider themselves to be the best person to answer a particular question. Part of the aim in asking questions to engineers and RE's and agents and quantity surveyors was to see if these people had different perceptions regarding certain matters. To test this, full replies were required from all interviewees.

ii) It was made clear that most of the questions were about general policies and procedures. Thus, where a company policy existed concerning a question area, it was details of this policy that were wanted. Otherwise, the interviewees would simply have to respond on the basis of their past experience.

iii) Some uneasiness had been felt, by the author if not by the interviewees, regarding some of the questions. It seemed that they might be considering these questions as a kind of test in which the answers were known and they would be subsequently assessed depending on their responses. It was felt necessary to make it clear that, in fact, the answers were not known, nor was it felt that there were 'correct' answers to these questions. The aim was to test their attitudes towards certain problem areas, rather than to test their knowledge.

During the actual interviews, it was found to be essential to stick closely to the questions on the questionnaire and not to allow the session to develop into a general discussion. As can be imagined, this was a particular temptation, but the few times it occurred it tended to throw the interview out of kilter. The conversation inevitably covered ground that was to be covered by subsequent questions. Another temptation was recognized in the way in which responses to qualitative questions were recorded. The propensity, that had to be guarded against, was that of helping the respondent to find the words to phrase his (it was always his!) answer. This was overcome by keeping silent until the answer had been given, and then getting agreement from the interviewee as to the form of words that most accurately represented his view. Although it was not possible for the current study, a good way of dealing with this situation would have been to use a lap-top computer. With a version of the questionnaire stored in a word-processor file, the questions could be brought up on the screen for both interviewer and interviewee to see and a response typed in at the time.

Apart from guarding against these two influences, the interviews were very instructive, not only in the responses to the actual questions but also in the additional information that they generated. In general, each interview took between $1^1/_2$ - $2^1/_2$ hours to complete, although one took 5 hours including a working lunch: this, after the interviewee had said he was really too busy! The analysis of the results will be covered in the next chapter.

CHAPTER 5

ANALYSIS AND DISCUSSION OF THE RESULTS

As we have learnt from the preceding chapter, the reaction from the organizations approached to the request for assistance with this study was mixed. Those who agreed to cooperate, did so enthusiastically, some asking for a copy of the report when produced. Quite a high percentage of the organizations approached, however, never responded at all: even after a follow up letter had been sent. In the event, of the 15 contractors, 15 consultants and 3 local authorities canvassed in the main study, only 7 contractors, 7 consultants and 1 local authority agreed to take part. Also, although each organization had been asked to provide two interviewees, very few actually did so. The overall response rate for the main study was 45% which, although somewhat discouraging at the time, may well in hindsight be seen as quite reasonable considering the sensitive nature of the matters being studied.

The data available for analysis thus comprised two parts: the completed questionnaires from these collaborating organizations together with those answered questions from the pilot interviews where the questions had not been changed in the main survey questionnaire. A total of 11 interviews based on the 'Engineer' questionnaire (including responses from local authorities and consultants) and 11 interviews based on the 'Contractor' questionnaire thus comprised the main data source. The 'Engineer' questionnaire responses were numbered from 1 to 11, and the 'Contractor' questionnaire responses were numbered from 21 to 31. Table 5.1 clearly shows for each of these interviews whether they were conducted with an agent/quantity surveyor or R.E./ Engineer and also where an organization provided two interviewees. It is felt that this method of classifying the data should be helpful in clarifying the details of interviews without revealing the names of the particular organizations who contributed to the study.

In this chapter, those questions that relate specifically to record-keeping will not be considered, being dealt with in a later section. For the remaining questions, the method of analysis adopted involved three principal stages, as follows:

i) Starting with a copy of the word-processing file containing the Engineer's questionnaire, the responses from each consultant or local authority interviewee were recorded beneath each question in turn. These responses were annotated with the code number of the interviewee concerned. The process was repeated for the Contractor's questionnaire using responses obtained from contractor's personnel and the results of this procedure may be found in Appendices 2 and 3.

ENGINEERS

Number	*Engineer/RE*	*Consultant/LA*	*Same firm as*
	Engineer	Consultant	
2	Engineer	Consultant	
3	Engineer	Consultant	
4	R.E.	Consultant	
5	R.E.	Consultant	
6	Engineer	Consultant	
7	Engineer	Consultant	
8	Engineer	L.A.	
9	R.E.	L.A.	10
10	Engineer	L.A.	9
11	R.E.	Consultant	

CONTRACTORS

Number	*Agent/Q.S.*	*Same firm as*
21	Agent	
22	Agent	26
23	Agent	
24	Agent	28
25	Agent (PM)	31
26	Q.S.	22
27	Q.S.	
28	Q.S.	24
29	Q.S.	
30	Q.S.	
31	Q.S.	25

Table 5.1 Key to the coding system used for analyzing questionnaires

ii) A further copy of the word-processing file containing the Engineer's questionnaire was created. This time, for each of the questions in turn, a summary was written of the responses listed in the above file, identifying where possible the most widely held viewpoint. This procedure was repeated with a copy of the Contractor's questionnaire.

iii) From the interim data produced in (ii) above, the rest of this chapter was written, grouping the results and discussions of those results under the following headings:

A The Format of the contract programme

B Checking the contract programme/details of the contract programme

C Use of the contract programme

D Delay claims: frequency of occurrence and award

E Preparation/assessment of claims

F Miscellaneous matters

In the following sections, it should be assumed that there are 11 responses to each 'Engineer' question and 11 responses to each 'Contractor' question unless stated otherwise. Use of the term 'Engineer' (with a capital E) will include both local authorities and consultants generally referring to all those who were interviewed using the 'Engineer' questionnaire. Similarly, the term 'Contractor' (with a capital C) will be used to mean those interviewed using the 'Contractor' questionnaire.

A The format of the contract programme

(Questions 1-6, 16 and 43A from the Engineer questionnaire and questions 1-5 and 35A from the Contractor questionnaire refer)

In this section, the questions relate to the particular format adopted for contract programmes, the obvious alternatives being: bar charts, CPM diagrams, linked bar charts and time/distance diagrams. Engineers and Contractors were both asked to say what format, if any, is usually specified for the contract programme. The Engineers were then asked to explain their policies on this matter. If nothing is specified by the Engineer, clause 14 of ICE5 simply requires a programme to show,'...the order of procedure in which he (the contractor) proposes to carry out the Works'. With this in mind, a question was put to both Engineers and Contractors to determine the format that is adopted where none is specified, i.e., when clause 14 alone dictates what is to be provided. Because of the importance of clause 14 in this area, Engineers and

Contractors were also asked to say whether the wording of this clause was adequate.

When asked whether they ever specified the format of the contract programme, the response showed an almost even split between the Engineers interviewed. Six replied that they never made any attempt to define format whereas five replied that they did specify. Of these five, three said that they always specified the format, the other two specifying format only on major projects. One interviewee added that the decision whether to specify was often left with the engineer in charge of preparing the contract documents. Standard clauses defining the format to be adopted by the contractor were available, he said, but were not always successfully incorporated, being sometimes misused.

The Engineers who specified the format of the contract programme all wished to ensure that the contractor had used a critical path approach in its production. However, the requirements they placed on the contractor to show the results of this exercise were different. Two said that they asked for a CPM/network-based format, whilst another required this together with a bar chart summary. One respondent asked for a bar chart that was based on a CPM analysis with the critical path identified, but did not want to see the network. The last of the five said that his organization had just begun to adopt the specification clause recommended in the new Notes for Guidance on the Specification for Highway Works (44). This clause requires that the programme should result from a CPM analysis but leaves a choice whether network diagram or bar chart format is used.

A question put to the Contractors deals with this same issue, asking what format is normally requested by the employer for Clause 14 programmes. Four replied that the format was not usually defined and another two commented that the format requested varied, sometimes CPM being specified, sometimes time/location charts, bar charts or nothing at all. Of those who recognized a common instruction in this area, three said that the bar chart was the usual format while two mentioned the linked bar chart. When asked to say how any particular approach was specified, three Contractors said that it was an informal arrangement. These three had identified bar charts or linked bar charts as the norm. Other methods of specification reported were:

i) by amending Clause 14;
ii) by using a specification clause;
iii) by including a note that the programme should be 'acceptable to the engineer' in the documents.

When the Engineers were asked to describe how they defined the programme format, the five who did specify all said that they used a specification clause for this purpose. One of these, as mentioned above, used the clause from the new specification. Another commented that the clauses used were adjustable and could be amended depending on the requirements of the scheme.

Question six on the Engineer's questionnaire asked why the respondents' organizations operated their particular policy concerning the format of the contract programme. Those who made no attempt to particularize in this area explained this policy by claiming that they did not wish to impose on or restrict the contractor. One view expressed was that an understandable programme could typically be obtained in this way. For those organizations who did instruct the format, their reasons for doing so were more varied, including:

i) wanting to identify at an early stage what the problems were going to be;
ii) wanting to make sure that the contractor had properly considered the job and made a good assessment of what he had to do;
iii) to assist the engineer to determine his design programme;
iv) a belief that Clause 14 (ICE5) is totally inadequate with regard to extension of time claims at a later stage;
v) tradition.

When unfettered by any particular conditions in the contract, the Engineers report that bar charts are the contractor's favoured form. All responses to the question in the Engineer's questionnaire on this theme mentioned bar charts. Seven only mentioned this format while the others added that linked bar charts and occasionally time/location charts are used. The responses from a similar question in the Contractor's questionnaire gave much the same picture. None of the Contractors would present their programme in CPM form given the option. Bar charts were again the most commonly mentioned form with linked bar charts and time/location charts suggested as a less likely possibility. The Contractors' reasoning behind this policy was that the bar chart was the easiest representation of a project plan to understand, the simplest and the most expressive.

It must not, however, be assumed that because contractors like to represent the contract programme in bar chart form, that they do not produce that bar chart from an initial CPM analysis. Indeed, question one on the Contractor's questionnaire particularly asks what system is adopted for the planning of major projects. Of the eight organizations responding, all but one would use CPM at least some of the time. Four firms always used CPM while the other three used CPM or bar charts depending on the size of the job.

Clause 14 provides a minimum requirement that a programme should be produced by the contractor while leaving it wide open what format should be adopted. When asked to say whether they felt that the wording of this clause was adequate in this respect, the Engineers who felt the need to amplify it with additional requirements said that it was inadequate. Those who left the definition of the programme format to be governed by this clause confirmed their belief that it was, in fact, adequate. These responses were as might have been expected. The Contractors who answered this question were also divided in their views. In this case, however, those who considered the clause inadequate were not looking for a more detailed specification of programme format. They wanted clarification of the contractual significance of the programme and a requirement that would force the engineer to approve the programme. Concerning the lack of definition of the programme format, the Contractors appear to be quite content with the freedom that the current clause gives. Comments such as 'suits the contractor' and 'sufficiently open' were made.

To summarize, the study found there to be no consensus on whether organizations fulfilling the role of the engineer should attempt to define the form in which the contractor prepares his contract programme. Those who felt a need to control the contractor in this way usually used a clause in the specification to do so. They appear to want to ensure that contractors use CPM in the planning process but do not always wish to see the network itself. For those Engineers who do not specify, and leave clause 14 of ICE5 to govern this process, this is done to allow the contractor maximum freedom. The belief is that an acceptable programme will result from such a policy. Left to their own devices, Contractors will not present their programmes in a CPM format. They prefer to use bar charts in most instances, with linked bar charts and time/location diagrams used on occasions. Although linked bar charts should show all the interdependencies between activities, experience of their use in this area suggests that only certain links will be shown. For a complex programme, it can be very difficult to show all the interconnections on such a diagram. This would suggest that, in general, contractors are opting to show as little of the network logic as possible in their natural choice of format. The very limited definition of the form of the contract programme contained in clause 14 was thus found to be most satisfactory to them. The study does nevertheless show that most contractors are using CPM to plan major projects, even though this may not be evident in the contract programmes they present.

B Checking the contract programme/details of the contract programme

(Questions 7-15A, 17 and 43 from the Engineer questionnaire and questions 6-10 and 35 from the Contractor questionnaire refer)

Clause 14 of ICE5, which requires the contractor to submit what has been called the contract programme, states that it should be submitted for the engineer's approval. The actual procedure adopted for this approval, with some details of programmes that have been submitted and ways in which they fail to provide the desired information form the basis of this section.

The first question on this topic put to the Engineers interviewed was,'Who checks the contract programme?' Most responses mentioned the R.E. as taking a major part in the check, but tended also to add that the engineer or nominated engineer would oversee the process. In the two instances where the R.E. was not involved, this was justified by explaining that in those organizations the resident engineers were employed just to supervise the Works. They would have had no involvement in the scheme prior to its start on site.

When asked for particulars as to how the check was carried out, the Engineers' responses were varied, but most incorporated the following points into their answers:

i) a check that the durations of activities defined by the contractor were sensible;

ii) confirmation that any specific restrictions stated in the contract had been complied with (target dates, staged completion, completion of the whole project);

iii) ensuring that a proper logical sequence had been adopted.

Other factors that were not so generally recognized were:

i) asking for plant resources;
ii) making sure that major tasks were identified;
iii) checking that activity size was reasonable;
iv) overlaps between activities should be realistic;
v) checking how float had been dealt with;
vi) ensuring that sensible outputs had been used;
vii) checking that the work of other contractors and public utilities had been taken into account;
viii) ensuring that <u>all</u> activities had been included;
ix) railway possessions needed to be identified;
x) holidays must be allowed for.

The duration of any activity can only be assessed if the resources applied to that activity are known. A question asking whether information on the contractor's resources was usually requested found that most Engineers did make such a request. However, even armed with this information, the expected outputs from those resources would have to be estimated to determine whether sensible durations had been chosen for the activities concerned. As we have heard, most of the Engineers interviewed considered that checking whether sensible activity durations had been assigned is an important stage in approving the contract programme. They obviously felt able to make such an assessment given information on resources and thus must have, or believe they have, a reasonable understanding of the outputs to be expected from particular resources.

The site work carried out prior to designing the questionnaire included detailed analyses of two contract programmes for major roadworks schemes. While carrying out these analyses it was realized that there will be instances where some aspects of a programme are so clearly wrong and yet of no obvious significance, that it might be thought not worth the effort of bringing them to the contractor's attention. An example of this is shown in figure 5.1, where on a time/distance programme filling is clearly being shown as taking place through an area that has been surcharged. The surcharge area was to be allowed to settle without disturbance and yet filling is shown right through the area when the settlement should be occurring. The plan is clearly showing operations that should not and would not happen. It is quite easy to understand how the mistake was made and, in fact, what the plan should be showing here. In such circumstances, would Engineers raise the issue or simply consider it not worth recording? Question 10 in the Engineer's questionnaire was included to try to test such a situation. The question asks whether Engineers consider it necessary to point out all the ways in which the contract programme fails to properly portray the construction process (however niggling). The responses indicate that

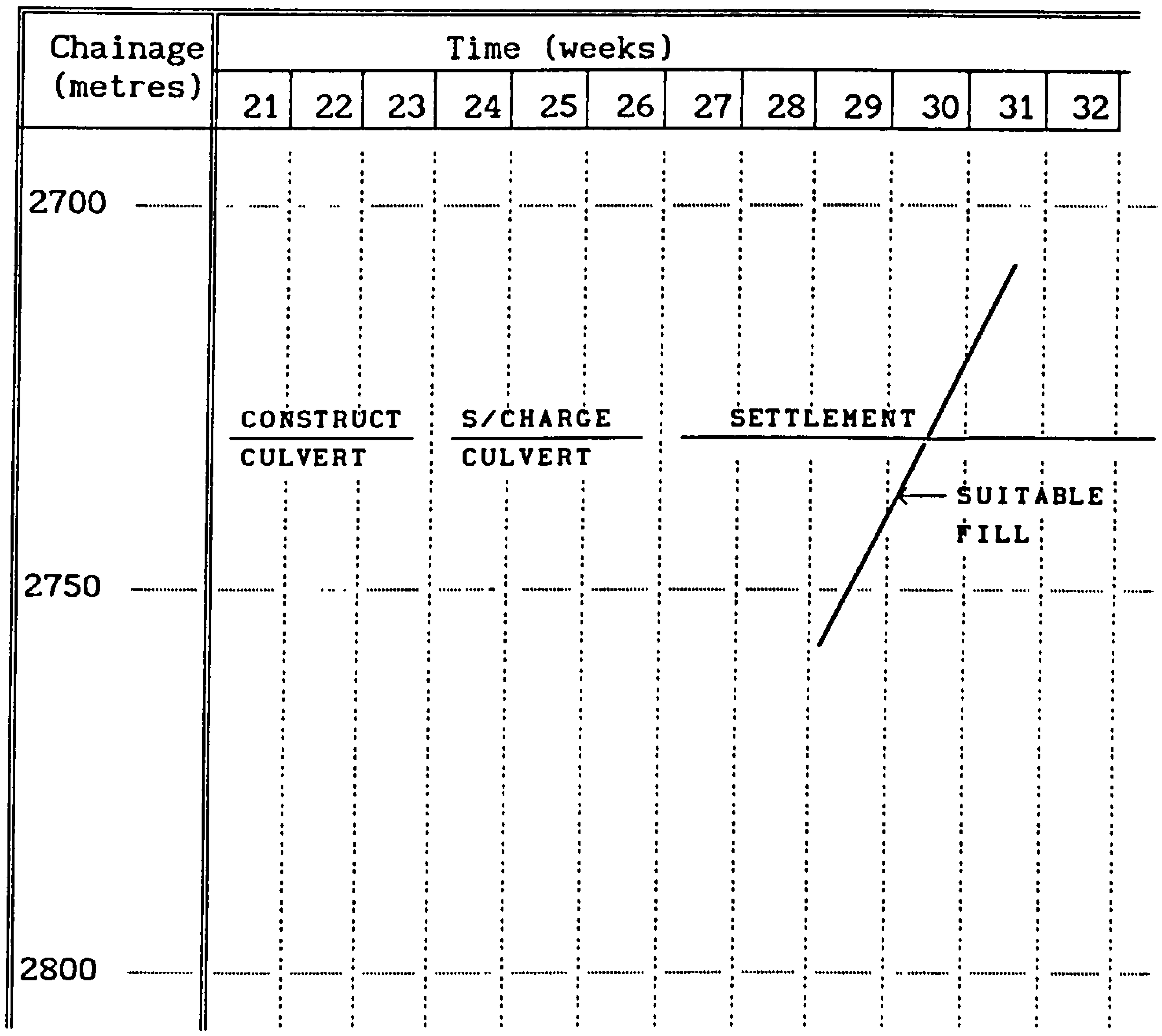


Figure 5.1 Example of minor errors in a programme

most (8 out of 11) would always clarify any uncertainty, whereas the remainder would take a more relaxed attitude. The reaction of the majority here might suggest a recognition of the importance of this programme at a later date, and thus the need to ensure that it represents, as well as possible, the likely outcome to the project.

Both Engineers and Contractors were asked to say what response was usually given to the contract programme following its assessment. Seven of the Engineers interviewed stated that they would normally approve the programme in a formal manner, although this often occurs only after revisions have been made. Where revisions are requested by the engineer but not incorporated by the contractor in a revised programme, it was pointed out that approval cannot then be given. A particular unwillingness to confirm approval of the programme was declared by three of the respondents. Two of these said that they tend not to give official approvals while the other admitted often having to do so. It is common to include some statement in any approval to the effect that the programme can only be achieved if the necessary resources are provided. One interviewee actually said that approval often includes a view that the contractor is being optimistic in his estimation of durations.

Only seven of the Contractors specifically addressed the question of formal approval. Of these, two stated that approval is rarely given, three said that approval generally occurs after some debate and the other two make particular efforts to get written approval. Other comments were:

i) the engineer tries to adapt it to suit his requirements regarding his information release (providing it is adequate for its purpose);
ii) sometimes confirmed as establishing only 'order of procedure';
iii) sometimes no response at all;
iv) very rarely positive, majority of time no comment, sometimes comment on insufficient time allowed, rarely comment on sequence;
v) request resources, suggest over-ambitious.

There is clearly considerable variation in the way in which engineers deal with the approval of the programme and this difference in approach is also evident in the response to question 9. This question, directed at Engineers, asks them to state how important they consider the checking of the contract programme to be. Three options were given: very important, fairly important and not important. Seven Engineers felt the check to be very important, and made comments that included: 'vital'; 'do a thorough job'; 'one of the most important documents'. The other four only rated the check as fairly important. They qualified this view with statements such as: 'there isn't enough time -

there are usually lots of other things to do'; 'it's the contractor's responsibility'. It had been anticipated that there might be some correlation between the Engineers who felt a need to define contract programme format and those who considered this check to be particularly important. This was not found to be so. Admittedly there were three Engineers who felt the check to be important and also specified format, but there were also three Engineers who while very concerned with the check, did not specify format.

When asked to say whether the contract programmes they received were usually presented in the format/detail they would wish, Engineers were divided in their replies. Of the nine who responded directly, four said no and five said yes. The common failings identified most frequently in these programmes concerned lack of detail, resulting in: block items; a broad brush approach; bill sections becoming activities; tie-ins not being sufficiently detailed. Two of the Engineers who said they were generally satisfied with their contractor's programmes actually recognized this failing. Other comments made were:

i) lack of interconnection;
ii) not fully displaying the logic;
iii) sometimes not aware of critical dates in the contract;
iv) scruffy handwriting, mysterious dotted lines;
v) sometimes don't appear too professional;

vi) always get satisfactory overview;

vii) basic errors and misunderstanding.

It is strange to relate that the comments in (i) and (ii) above, were both made by Engineers who did not feel a need to specify the format of the contract programme!

On similar lines, Contractors were asked to say which activities they found most difficult to represent properly in a project plan. Four respondents were unable to identify any particular problems, but those who could identify difficult areas mentioned the following:

i) finishings - diverse activities are often grouped together into one;

ii) weather-sensitive activities, viz earthworks and drainage;

iii) activities you know least about, especially subcontractors work.

The combining of several activities into one, as quoted in (i) above and that may result from (iii) also, might well be the source of the Engineer's complaint regarding lack of detail and use of block items.

All the remaining questions in this section relate to specific details of contract programmes and were asked of both Engineers and Contractors. The first of these concerns whether float is ever shown in such programmes. The response from Engineers was predominantly affirmative, with only one Engineer answering 'no'. The Contractors, who were asked if they ever showed float in their programmes were equally split on this question. Ten clear responses were made: five saying 'yes' and five saying 'no'. The other Contractor questioned said that the duration of an activity can include float! It should be noted that the responses from Engineers and Contractors are not inconsistent here: the Engineers having only said that float is sometimes shown, not always. A further question asked the respondents to specify to whom they thought that any float shown in the contractor's programme should belong. A choice was available from: contractor; employer; whoever needs it first; other. Almost all confirmed their views that the float should belong to the contractor. One Engineer commented that the employer could use this float if the contractor doesn't need it. Two comments were made by Contractors: one that this float gave the contractor flexibility and the other that float is not shown to avoid any argument.

The last two questions were prompted by a desire to investigate the ways in which contractors may attempt to use the programme to constrain the engineer. They ask the question whether activities are ever included in the contract programme that are to be carried out by the engineer. If so, are they considered contractually binding? Most Engineers (6 out of 10) and Contractors (8 out of 11) recognized or adopted this strategy in programmes they had received or provided. Concerning whether an approved programme containing such activities could be said to bind the engineer to comply with the scheduled dates, four Engineers and six Contractors felt that it could.

To sum up, the study found that programmes are usually checked by the R.E., often with an overview from a nominated engineer. This check tends to concentrate on ensuring that sensible durations are adopted for the project's activities, that a logical sequence is employed and that the specific restrictions contained within the contract have been adhered to. Most Engineers ask for details of the contractor's resources and appear able to assess whether reasonable outputs have been estimated by the contractor in arriving at the activity durations. Formal approval of the programme will usually take place providing the contractor deals with any matters raised by the engineer, although there are some engineers who tend not to give official approval. Equally, there are some Contractors who go out of their way to get an approved programme from the engineer. Different views of the whole procedure of checking contract programmes were identified, with some Engineers considering the check to be very important while others were less enthusiastic. The most frequently mentioned failing in programmes concerned lack of detail and some programmes were said to be rather unprofessional in their presentation. The lack of detail identified by Engineers was echoed by Contractors when commenting on those activities that they find difficult to represent on the contract programme. Float is sometimes evident in these programmes as are activities that are to be carried out by the engineer. These are felt by some to be binding on the engineer if the programme has been approved. The available float is generally accepted as belonging to the contractor.

C Use of the contract programme

(Questions 17A, 18, 19 and 45 from the Engineer questionnaire and questions 12, 13 and 37 from the Contractor questionnaire refer)

We have already considered the ways in which the contract programme may be requested and the procedures adopted for its approval, but what of the use of the programme both during and following the contract period? The questions grouped under this heading aim to identify not only specific uses made of the programme, but also to ascertain attitudes towards those uses, in terms of their importance to the people concerned. It should be noted that only one of the questions, question 18, was put to Engineers alone; all other questions had counterparts in both Engineer's and Contractor's questionnaires.

As stated above, the interest in this section lies not simply in identifying all the uses to which the contract programme may be put, but also in attempting to determine their significance. Some uses, in fact, can be readily accepted, having been recorded as common practice in the literature. It was decided to define three such uses and to ask interviewees, both Engineers and Contractors, to rank them in order of importance. The uses were:

i) use as the agreed plan against which the effects of delays to the project may be determined;

ii) use to define the agreed method of working and the order in which activities are to be carried out;

iii) use as a control tool against which actual progress may be compared and future action decided.

The interviewees were asked to nominate one of these uses as most important (ranked 1), one as least important (ranked 3), leaving the other to be ranked 2. There were 9 full Engineer responses and 9 full Contractor responses to this question. Only two respondents felt unable to make a distinction between the options.

Table 5.2 contains the results obtained, with some analysis of the figures. The number of interviewees selecting the various rankings for each use is shown both as a total and

Use of programme	Choice	ENGINEER						CONTRACTOR					
		No selected			Weighted			No selected			Weighted		
		ALL	Eng	R.E	ALL	Eng	R.E	ALL	Agent	Q.S	ALL	Agent	Q.S.
TO SHOW EFFECTS OF DELAYS	1	1	1	0	3	3	0	5	2	3	15	6	9
	2	6	4	2	12	8	4	1	1	0	2	2	0
	3	2	1	1	2	1	1	3	2	1	3	2	1
	%age				31	33	28				37	33	42
	full range %age				42	48	33				61	48	76
TO SHOW METHOD OF WORKING	1	1	1	0	3	3	0	3	2	1	9	6	3
	2	1	0	1	2	0	2	2	1	1	4	2	2
	3	7	5	2	7	5	2	4	2	2	4	2	2
	%age				22	22	22				31	33	29
	full range %age				15	15	15				42	48	36
TO EXERT CONTROL	1	7	4	3	21	12	9	1	1	0	3	3	0
	2	2	2	0	4	4	0	6	3	3	12	6	6
	3	0	0	0	0	0	0	2	1	1	2	1	1
	%age				46	44	50				31	33	29
	full range %age				88	82	100				42	48	36

Table 5.2 Importance of the uses of the contract programme

also split into the different types of respondent, viz. agent/quantity surveyor or R.E./nominated engineer. A weighting was then applied to these choices, with the ranking '1' attracting a weighting of 3, '2' attracting a weighting of 2 and '3' a weighting of 1. The weighted values of the choices made are also shown in the table. To get some indication of majority views, two other figures have been calculated. These are the percentage of total marks awarded in each category (X) and a figure that aims to show more clearly where the main concerns of the interviewees lie. This second figure recognizes that the worst percentage that one use can attract is 17% while the best is 50%. Thus, if we subtract 17% from the percentage X and divide it by 33 (50% - 17%), we produce a percentage that has a best value of 100% and a worst value of 0%. These percentages nominally called 'full-range percentages' are also shown in the table.

It is accepted that with the relatively small sample of interviews undertaken, it would be unwise to attempt to read too much into the figures thus derived. However, in considering the 'full-range percentages', some points seem worthy of note. These are:

i) The Engineers in general appear to be most concerned with using the programme for control (88%) and least concerned with its use to indicate the agreed order of construction (15%). This should not be taken to mean that Engineers are not interested in this second use, simply that they feel it to be of less significance than other uses. There is little discernible difference between the views of the nominated engineers and the R.E.s on this matter.

ii) Although the Contractors do appear generally more concerned with the use of the programme to identify the effects of delays (61%) than with the other two uses (both 42%), the difference between these is much less than differences in the Engineers' views. Indeed, the agents seem equally concerned with all uses while quantity surveyors show a particular interest in use of the programme for delay claims.

It is suggested that the above indications, in particular that the Engineer's prime concern may be to use the contract programme as a control tool, should be considered when making recommendations on how this programme might best be requested by the engineer.

In an attempt to recognize any other applications of contract programmes, both Engineers and Contractors were asked to identify the particular uses to which their programmes were put. Surprisingly, none of the Engineers mentioned that the programme could be consulted to define the order in which the activities of the contract ought to be carried out. If the R.E. is to plan ahead and be prepared for the next operations on site before they begin, it is the programme to which he should be referring to identify these operations. The other two uses, previously discussed, were clearly present in the responses and whereas all replies mentioned monitoring progress, just over half of them included dealing with delay claims. This supports the previous view that the Engineers are mainly concerned with using the programme to control. Other recognized areas in which use is made of contract programmes were:

i) to provide feedback to the design office;
ii) possible use to assist in analysing the contractor's performance;
iii) to advise third parties;
iv) to provide advice to the client on cash flows.

When confronted with the same question, most Contractors included the three uses already discussed in their answers and individuals also added:

i) producing a cost envelope for the client;
ii) bringing on subcontractors;
iii) used to schedule resources;
iv) for budgeting and ordering materials.

Both (i) and (iv) above suggest that Contractors are sometimes using their plans together with cost information in the form of a 'cost model'. CPM software firms will, of course, point to such a use of their product, but it is not generally known whether contractors actually use CPM in this way.

If good advice is to be given regarding the ways in which contract programmes should be specified and checked, then the uses that might be made of such programmes will need to be known. The above information should be useful in this respect.

If contractors and engineers are to make full use of the contract programme, they will need a good working knowledge of it. In an attempt to assess how good an understanding the site staff will generally have, Contractors and Engineers were both asked to comment on each other's typical level of knowledge of contract programmes. They were asked to say whether their opposite numbers would have a good, fair or poor working knowledge. Almost all the Engineers interviewed said that the agent would have a good working knowledge of the contract programme. There was, however, a general feeling that other members of the contractor's site staff would not have anything like as good an appreciation. The Contractors were not as charitable to the resident engineer, with only 5 responses suggesting that the R.E.'s comprehension of these matters would be good. The other responses indicated only a fair or poor grasp with a clear indication that some were good while others were not so good. It also was evident that other members of the R.E.'s staff would be expected to have less understanding than the R.E.. There certainly seems to be a belief that good understanding of the contract programme, where it exists, will be limited to the top individuals on the site.

One argument occasionally put forward by engineers to justify their lack of confidence in the value of contract programmes is that the contractor may well have developed his programme with future claims in mind. That is, that he may have so scheduled his activities and selected their durations to take advantage of problems that he can see are likely to occur. Instead of attempting to predict the way in which construction should proceed, the suggestion is that he is organizing his programme to ensure that he can capitalize on any problems that arise. Question 18 was incorporated into the Engineer's questionnaire specifically to test for such attitudes. Engineers were asked to say whether they believed that contract programmes were presented more with the intention of supporting future claims than as an attempt to predict how the contract would actually proceed. The respondents were required to select a response in the range 1 - 5, from 1 (don't believe) to 5 (strongly believe). The results were difficult to analyse as few of the interviewees gave unqualified answers. The general response, however, for most contractors was closer to 1 than to 5, suggesting that for these contractors this was not an issue. Five responses did suggest that it depended on the contractor and that some were particularly prone to such methods. One interviewee added that there was a tendency to make all activities critical.

The main points from this subsection may be summed up as follows:

i) Of the well-documented uses of contract programmes, it is the use of the programme as a control tool that is considered most important by Engineers. Contractors, on the other hand, gave fairly equal weighting to the three main uses of the programme that were specified.

ii) Engineers consider contractor's agents to have a good working knowledge of the contract programme, but Contractors are not quite so impressed with the R.E.'s knowledge of these matters. It undoubtedly appears that a good understanding of this document is likely to be limited to the top staff in each site organization.

iii) There appears to be no strong belief that contractors in general are preparing their programmes to take advantage of future claims situations. However, it appears that some contractors are renowned for operating in this way.

D Delay claims: frequency of occurrence and award

(Questions 21-27 and 47 from the Engineer questionnaire and questions 14-20 and 39 from the Contractor questionnaire refer)

The questions discussed in this section are those that have been included in an attempt to get some measure of the frequency with which delay claims occur and the extent to which they are paid. The only extraneous question refers to the regularity with which liquidated damages are deducted. It is, however, considered that this aspect is so closely related to the subject matter of this section that it is also best dealt with here. All the questions covered here occur in identical or near identical form in both Engineer and Contractor questionnaires.

The information elicited is thus of a quantitative nature and, it might have been expected, should have been easy to obtain in the form required. This was not the case, for two reasons. The first problem, that was to some extent foreseen, provoked a dilemma regarding the wording of the questions. These had to be framed having anticipated the type of information that the interviewees might be expected to have readily available. It was considered unreasonable to require them to do work in preparation for the interview. Thus, although it was believed that the frequency of delay claims may well be related to the size of the contract concerned, it was felt that the respondents would not have information broken down in this way. The questions were, therefore, composed to suit the anticipated availability of information. This meant that responses were typically generalized from each interviewee's memories of their experiences. Though not as specific as would have been liked, they were considered the best that could be obtained in the circumstances. The second problem concerned the phrasing of the questions aimed at identifying the extent of awards on extension of time claims. Although the questions had been piloted, it was not until quite late in the interviewing period that the inadequacy of these questions was fully realized. At this stage, question 23 on the original Engineer's questionnaire and question 16 on the original Contractor's questionnaire were each replaced with two questions: 23 & 23A and 16 & 16A respectively. As a good deal of the interviewing had been done by this time it was only possible to obtain answers to these revised questions from 5 Engineers and 3 Contractors. Despite the two problems discussed, it is still believed that the information collected here will be useful, particularly because so little information is available in this area.

The main questions in this section follow a simple pattern: first the frequency of extension of time claims is addressed. This is then followed by questions to determine the extent of awards for such claims and an opportunity for respondents to declare the accuracy of the information they have provided. This procedure is then repeated with acceleration claims. The quantitative information that resulted from these questions is presented in table 5.3, and will now be discussed in detail.

In trying to identify the frequency with which extension of time claims are made, it was felt necessary to stipulate that such claims should only be recognized if they are submitted with supporting evidence. Often letters are sent by the contractor that state that an extension of time may be needed as a result of some delay caused by the employer or engineer, but that never actually lead to a claim. Instances such as these are not considered to be real claims and the use of the phrase, '...with supporting evidence', was intended to make this clear to respondents. To elicit sensible information regarding the frequency of extension of time claims, two questions were used. The first asks on what percentage of contracts extension of time claims with supporting evidence occur. The second requests the average number of claims that are made on these contracts. For the first question, most responses from both Engineers and Contractors indicated a figure of 50% or more and from the table it can be seen that the average percentage was 60% and 70% respectively. On the second question, both Contractors and Engineers said that different causes of delay were often lumped together into one claim, although the Engineers also gave an average figure of two causes of claim per contract.

Question No.	Short description	Average responses ENGINEER		CONTRACTOR	
21(11) 14(11)	Percentage of contracts on which E of T claims with supporting evidence are submitted	60%		70%	
22(11) 15(11)	On these contracts, average number of E of T claims made	2, may be rolled into one claim		1 claim, delays lumped together	
23(5) 16(3)	Percentage of E of T claims made without subsequent attempt to recover overheads	10% or less		very few	
23A(5) 16A(3)	How often are E of T claims granted:	*time (%)*	*cost (%)*	*time (%)*	*cost (%)*
	in full	13	6	10	0
	in part	71	76	70	95
24(11) 17(10)	Accuracy of data	fairly		fairly	
25(11) 18(11)	How often are acceleration claims with supporting evidence presented?	rare		26%	
26(11) 19(11)	How often are such claims granted?	>50%		70%	
27(7) 20(8)	Accuracy of data	fairly		fairly	
47(11) 39(11)	How frequently, if ever, are liquidated damages deducted?	rare		rare	

Table 5.3 Delay claims: frequency of occurrence and award

It was in attempting to find out the extent to which these claims were generally awarded that problems with the wording of questions arose. The initial question adopted in this area was confusing in that it required interviewees to comment on the extent of awards without separating the two aspects of time and costs. As has already been stated, in the revised version two questions were used in place of the original one. The first question addresses the possibility that some extension of time claims may be submitted without any subsequent attempt to recover overheads. That is, that the contractor would be requesting an extension of time purely to delay the point at which liquidated damages might be deducted. Responses from both Engineers and Contractors were in agreement in recording that this situation occurs at best infrequently. Contractors almost always back up these claims with a request for the cost of financing the extension claimed. Given that the claims will generally consist of two elements: a claim for time and a claim for overhead costs, the second question was framed to identify the extent to which these were accepted. Although the number of responses was quite low, the average figures quoted by both Engineers and Contractors were fairly consistent. It appears that the likelihood that all the costs cited in such claims will be paid is very small (0 - 6%). The likelihood that all the time demanded will be awarded is slightly higher but still only in the range 10 - 13%. Partial payment or acceptance of a right to an extension was set much higher than this with figures of between 70% and 95%. Most claims that are taken seriously by the contractor and submitted with back-up, it seems are likely to succeed, at least partially. When the interviewees were asked to say how accurate they considered this information to be, given a choice between 'very accurate', 'fairly accurate' and 'an impression only', the general choice from both Engineers and Contractors was 'fairly accurate'. This question was incorporated with a view to allowing the respondents to declare their confidence in the data provided and to confirm that this information was of an approximate nature.

A question to determine the frequency with which acceleration claims with supporting evidence were submitted caused a number of comments, mainly from contractors.
These were:

i) acceleration claims are mainly the result of liability later accepted by the engineer;

ii) we don't voluntarily accelerate even though a Clause 46 notice is issued, (most contractors ignore a Clause 46 notice) - we only voluntarily accelerate if it is our own problem;

iii) the as-built programme is the accelerated programme, the engineer could instruct acceleration under Clause

51 (doesn't appear that way).

The only comment made in an Engineer's interview was that it would be necessary to change the name of the claim to a disruption claim for the engineer to pay it. There appears to be some uncertainty as to the ground rules for such claims and this may be a result of the fact that these claims may be quite rare. Indeed, that is what the majority of the Engineers said in answer to this question. However, of the seven Contractors who gave a percentage here, the mean value was 26%. Could there be some disagreement as to exactly what constitutes an acceleration claim in the minds of engineers and contractors?

When asked to say how often acceleration claims are granted, most respondents were relying on experience of a very few such claims and some had never been involved in one. The general feeling was that these claims would be granted in most cases. One Engineer respondent said that the contractor wouldn't submit such a claim unless he had a good case. He would find some alternative method. Again the respondents felt that the information given on acceleration claims was fairly accurate.

If the contractor on a project fails to complete within the original or extended time for completion, then the employer will typically have the right to deduct liquidated damages for each day/week the project is late. Such damages are usually written into an ICE5 contract, but it is not generally known to what extent this right is ever invoked. Questions put to both Engineers and Contractors to determine this information met with a similar response. Some interviewees had never had any experience of liquidated damages being deducted, but others confirmed that it did happen, albeit very rarely. In all but one instance, figures quoted to define the frequency of deduction were 10% or lower. It is not surprising then, if some sections of the industry are of the impression that these damages are never collected.

Unlike the previous sections of this chapter, no summary will be written here, as it is considered that table 5.3 is the most effective summing up of the results obtained possible. It is simply worth noting that matters concerning the preparation and assessment of extension of time claims, in particular, will have to be dealt with on most major contracts. This surely makes the value of research in this area very important.

E Preparation/assessment of claims

(Questions 20, 28-36A, 44 & 44A from the Engineer questionnaire and questions 13A, 21-28, 36, 36A & 39A from the Contractor questionnaire refer)

As we have seen from the literature search in chapters 1 and 2, much of what has been written on this area of contract administration concerns the difficulty of assessing a contractor's claims for delay and disruption. In the U.S.A., an understanding has developed of a generalized approach to dealing with such problems, but there appears to be no comparable approach accepted in the U.K.. Under ICE5 conditions regarding claims for extensions of time, the engineer is required to,'...make an assessment of the extension of time (if any) to which he considers the contractor entitled for the completion of the Works...' He must do this in a fair manner. Exactly how this is to be done, however, is left to the engineer to decide. Texts relating to the U.K. experience suggest that the application of the critical path method will make for a more just solution, but usually only give very simplistic examples to back this up. The engineer thus has little supporting material to guide him in his deliberations on such problems. In the absence of any legal precedent or recognized procedures, it is suggested that the views of other professionals working in this field may be the most useful guide that can be provided here. With this in mind, those questions addressed to both Contractors and Engineers specifically concerning the preparation and assessment of claims will now be analysed. If general areas of common agreement between these two main parties can be recognized and accepted, this may help to simplify the deliberations on some of these complicated claims situations that have been found to occur so frequently.

The particular questions considered in this section have been further subdivided as an aid to understanding. The subsections adopted are as follows:

1. General principles
2. Specific cases
3. Claims procedure
4. Claims - miscellaneous

QUESTION NUMBERS QUOTED IN THESE SUB-SECTIONS RELATE TO THE ENGINEER QUESTIONNAIRE

1. General principles

As a first and rather crude attempt to determine attitudes in this area, four statements were presented to the interviewees. They were asked to say whether they agreed or disagreed with the statements and invited to comment as they wished. The statements were selected, in part to check whether certain principles discussed and pronounced on in the literature were generally accepted by the profession (Q28 & Q31). There were also, however, questions to test out attitudes on matters that have not been so widely considered (Q29 & 30). The aim here, as in other parts of section E, is not only to record and analyse decisions, but also to try to ascertain on what basis such decisions are made. The results and comments made on each question will now be considered in turn and to assist this process, the results have been tabulated in table 5.4.

The first question, number 28, suggests that a claim for extended overhead costs should not succeed unless the time for completion is likely to be exceeded. This view, which is proposed by Powell-Smith and Stephenson (8) and opposed by Abrahamson (2) was discussed at some length in chapter 1 of this thesis. The interviewees, both Engineers and Contractors, were unequivocal in their disagreement with this statement. Only two comments were made: one by an Engineer who stated that a contractor may be due an extension of time even if he can still finish on time, and the other by a Contractor stating that the time for completion affects only liquidated damages. Whatever the views of writers and commentators on this issue, the industry appears to be quite clear as to its opinion.

In question 29, if a contractor's programme shows completion in 18 months and he actually completes in that time, the statement says that no extended overhead costs can ever be justified. The supposition behind this statement is that having anticipated paying overheads for the 18 month period, even if he could have completed in (say) 16 months and was delayed 2 months by the employer, the contractor would have suffered no loss. He has only had to pay overheads for the time he expected to have to pay them. All the Contractor responses disagreed with this view. This might have been expected, but there was also a

Note: Question numbers relate to the Engineer questionnaire

Q28 There is no point in making a claim for extended overhead costs unless the time for completion is likely to be exceeded.

DECISION	ENGINEER			CONTRACTOR		
	ALL	Eng	R.E.	ALL	Agent	QS
Agree						
Disagree	11	7	4	11	5	6
Other						

Q29 If the contract programme (clause 14) showed completion in 18 months and the contractor actually completed in 18 months, no extended overhead costs can ever be justified.

DECISION	ENGINEER			CONTRACTOR		
	ALL	Eng	R.E.	ALL	Agent	QS
Agree	2	1	1			
Disagree	8	5	3	11	5	6
Other	1	1				

Q30 If the Engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the contractor from justifying an extension of time with recovery of overhead costs for the same period.

DECISION	ENGINEER			CONTRACTOR		
	ALL	Eng	R.E.	ALL	Agent	QS
Agree	4	3	1	2		2
Disagree	6	3	3	9	5	4
Other	1	1				

Q31 Providing the Engineer never actually instructs the contractor to accelerate, then no acceleration claim can be justified.

DECISION	ENGINEER			CONTRACTOR		
	ALL	Eng	R.E.	ALL	Agent	QS
Agree	3	3		3	2	1
Disagree	7	4	3	7	2	5
Other	1		1	1	1	

Table 5.4 Assessment of claims: general principles

majority of the Engineer responses against it too. Some of the comments made show that some respondents would have been considering not extended overhead costs, but additional overhead costs for the 18 month period occasioned by any additional work instructed by the engineer. There still, however, seems to be a general distrust of the logic supporting this statement. A similar scenario is examined in section 2 (Question 35 (diagram A)).

The statement contained in Question 30 resulted from a discussion with a resident engineer during a visit to one of the sites on which the preparatory work for the questionnaires was being conducted. He related that in the past he had been involved in a contract on which the engineer had taken the initiative to award an extension of time without costs as a result of exceptionally adverse weather. This had been done specifically to prevent the contractor from claiming an extension of time with costs for some cause that was the employer's responsibility. Irrespective of the rights or wrongs of such action, this situation raises the general issue of alternative critical paths and parallel delays and for this reason was felt to be worthy of inclusion. The actual statement adopted was,'If the engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the contractor from justifying an extension of time with recovery of overhead costs for the same period'. Amongst the Engineers, 6 disagreed of whom 2 made comments suggesting that this would be somehow underhand, while 4 agreed, 2 of these believing that the contractor would find another way to recover his costs. The contractors were much more strongly opposed to this statement, with 9 disagreeing and 2 agreeing. The comments made, however, did not particularly attempt to disprove the statement, being general accounts of their views on dealing with weather in claims situations. Although the question is a rather complex one it was surprising that none of the comments anticipated the possibility that a further extension of time beyond the first might be awarded: this time with costs. Also, the chance that another parallel path through the network, much delayed by the employer, might supersede the impact of the path on which the type N delay occurred was not considered. Is it possible that delays to the contract are not seen or perhaps not understood in this way?

The final question concerns acceleration claims and states that providing the engineer never actually instructs the contractor to accelerate, then no acceleration claim can be justified. The responses from both Contractors and Engineers were identical, with 7 responses disagreeing with the statement and 3 agreeing. The comments showed a recognition of the possibility of what is sometimes known as 'constructive acceleration'. That is, if the engineer fails to award a properly deserved extension of time during same period'. Amongst the Engineers, 6 disagreed of whom 2 made comments suggesting that this would be somehow underhand, while 4 agreed, 2 of these believing that the contractor would find another way to recover his costs. The contractors were much more strongly opposed to this statement, with 9 disagreeing and 2 agreeing. The comments made, however, did not particularly attempt to disprove the statement, being general accounts of their views on dealing with weather in claims situations. Although the question is a rather complex one it was surprising that none of the comments anticipated the possibility that a further extension of time beyond the first might be awarded: this time with costs. Also, the chance that another parallel path through the network, much delayed by the employer, might supersede the impact of the path on which the type N delay occurred was not considered. Is it possible that delays to the contract are not seen or perhaps not understood in this way?

The final question concerns acceleration claims and states that providing the engineer never actually instructs the contractor to accelerate, then no acceleration claim can be justified. The responses from both Contractors and Engineers were identical, with 7 responses disagreeing with the statement and 3 agreeing. The comments showed a recognition of the possibility of what is sometimes known as 'constructive acceleration'. That is, if the engineer fails to award a properly deserved extension of time during the period of the works, the contractor speeds up to complete within the original time for completion and the engineer later decides that the extension should actually be awarded. In such a case, the contractor has no need for the late extension but may have suffered additional costs as a result of having to complete work at a faster rate than was reasonable. Such costs should be recoverable by the contractor for having to accelerate, even though no specific order to accelerate was given. This is a generally recognized scenario and perhaps the reason for a number of the respondents not identifying it results from the fact that so few acceleration claims are made.

Rather than summarize after each subsection, a general summary for the whole of section E will be given at the end of the section. This approach has been adopted because similar matters are addressed in different ways in each of the subsections. For this subsection, no noticeable difference in view was discerned between either engineer and R.E. or between agent and quantity surveyor.

2. Specific cases

As an alternative means of shedding light on the way in which professionals in the industry consider delay claims, it was decided to try to describe fully some particular outcomes to contracts and to ask the respondents to recommend solutions. This was the approach adopted in questions 20 and 35, although different methods were used to do this. In question 20 the whole scenario was described in words, while for question 35 four diagrams were drawn to chronicle the outcomes to four contracts.

Beginning with question 20, this is the only question in the questionnaire that considers the need to make a decision on extension of time matters part way through a project. It was positioned just before the questions on frequency and award of claims as an attempt to attune the minds of the respondents to the matters to be discussed. It is, however, properly considered in the current context. The question is as follows:

> 'Six months into the contract, it is clear that the employer has delayed a part of the Works in such a way that the whole of the contract will be delayed by 2 months. The time for completion is 24 months and the contractor's original programme showed completion in 20 months. What should the contractor do?'

Of the 9 Engineer responses, 7 said that the contractor should request an extension of time, 2 that he should claim for a delay with costs. Of the 10 Contractor responses, 6 said that the contractor should claim for an extension of time, 4 that he should claim for delay; not an extension of time.

It is clear from the figures that at the point of consideration, no extension of time will be needed. Yet, if the contractor was to allow his programme to slip, or further delays occurred, the situation would change. An extension of time might then be necessary to defray the deduction of liquidated damages. This fact was clearly understood by the respondents of whom some added very interesting comments, as follows:

i) 'Claim extension of time - 20 months is new time for completion (we allow the contractor to decide the time for completion)'. Engineer

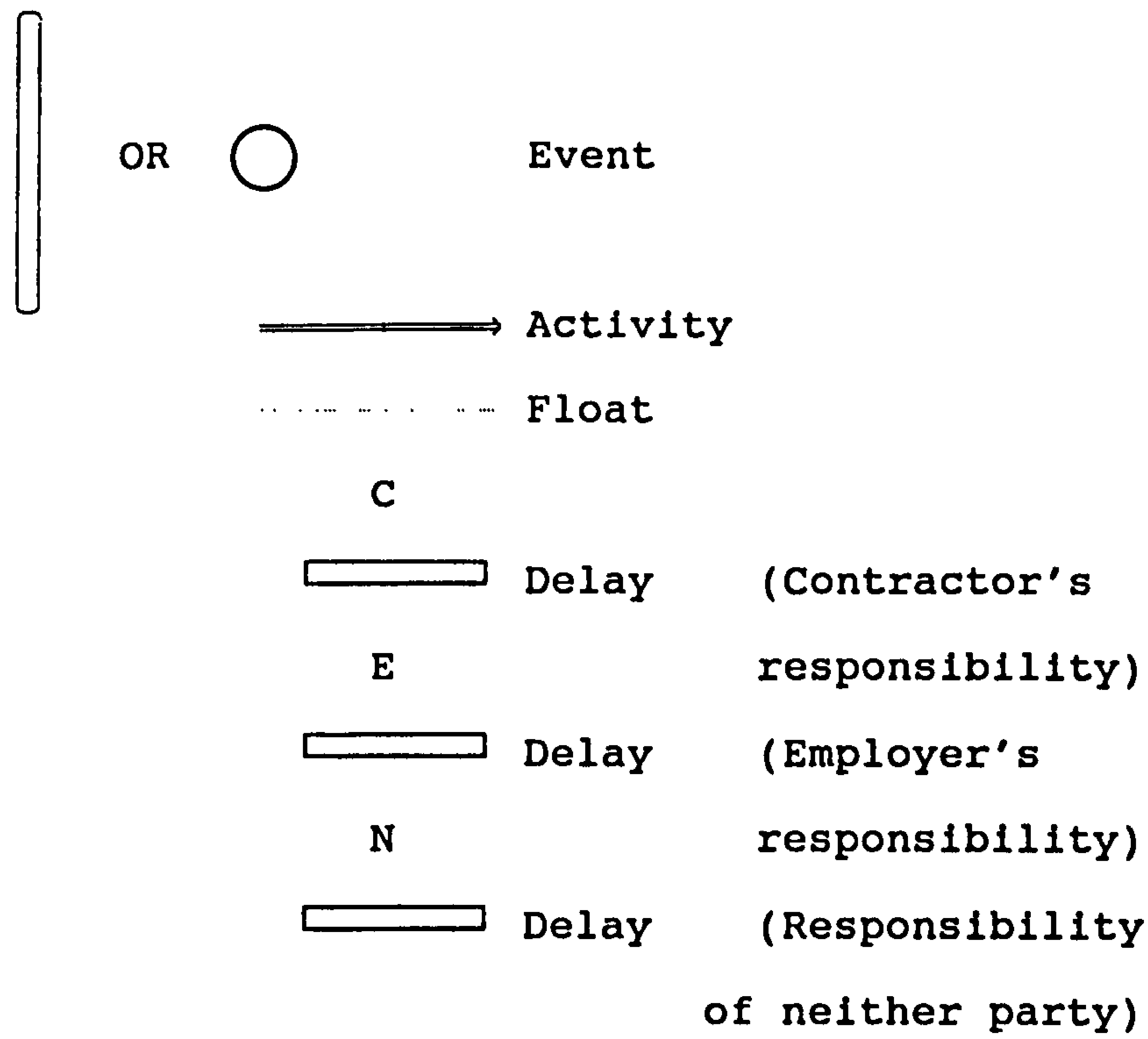
ii) 'Ask for extension of time (some contractors make a statement on their programme pointing to the time between their early completion and the contract time for completion and stating this to be "period for use by contractor for circumstances other than entitlement to extension of time")'. Engineer

In assessing the effects of a delay part way through a contract, the engineer must attempt to predict how the contract will proceed in the future. For some delays, where (say) the whole site was brought to a standstill as a result of the employer's actions, then the effect on the completion of the whole project is undeniable. However, if the delay was not so wide-ranging and yet at the time appeared that it would necessarily delay the whole project, a later assessment might prove that another path through the network had become critical. This second path might then control the completion of the project and might only contain within it, delays for which the contractor was responsible. In such a situation, awarding an extension of time rather than simply recognising a delay for which the employer is responsible and that could lead to an extension of time might lose the employer the right to deduct liquidated damages. Recognition of a fundamental delay to the project rather than awarding an extension of time, however, was not favoured by most Engineers. It appears that such delays tend to be closely linked to ideas of extensions of time.

In question 35, the intention was to illustrate using time-scaled CPM diagrams, a few simple yet interesting scenarios that might have to be dealt with in a claims situation. Although the simplest cases were chosen, it was still found necessary to clarify a number of points. For this reason a checklist was developed to help explain the diagrams before they were shown to the interviewee. The points were as follows:

i) For each case, two diagrams are shown: one showing the contractor's original programme (PLANNED); one showing the actual 'as-built' record of work (ACTUAL).

ii) The diagrams use time-scaled activity-on-arrow format, in which the following symbols are adopted:



iii) It is assumed throughout that the existence of one delay has not affected the duration or timing of subsequent delays. For instance, if the construction site is not available at the start of the Works, any contractor delay might be a result of his holding back his preparations. Such effects are assumed not to have occurred.

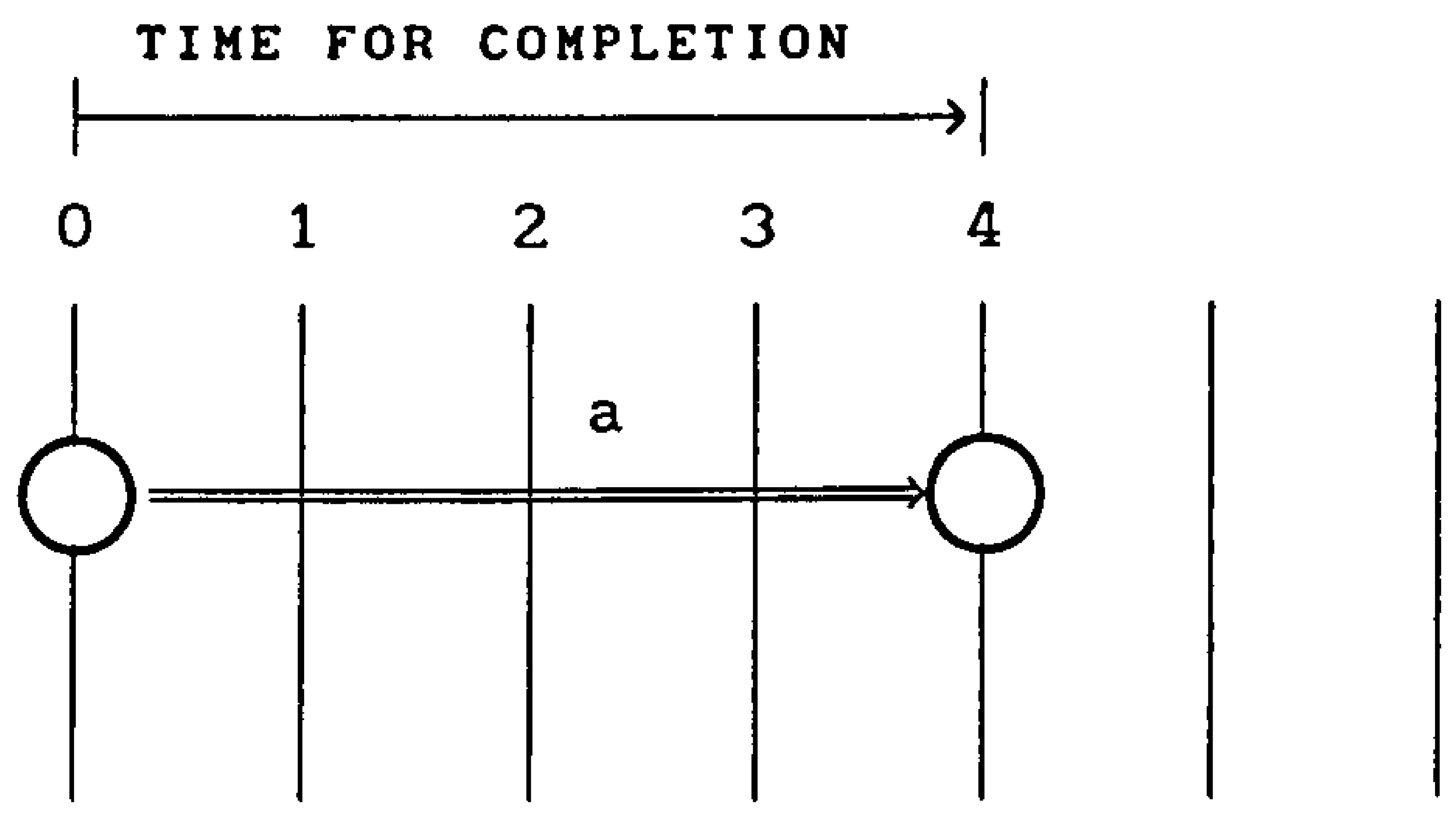
iv) It is to be assumed that no acceleration has taken place.

v) In each case, the interviewee's views are sought on the contractors rights to: an extension of time; the recovery of overhead costs, and the employer's rights to deduct liquidated damages.

The actual diagrams used during the interviews were A3 size and these are reproduced at a much smaller scale together with the accompanying description and a summary of the results obtained as figures 5.2 - 5.5.

In diagram A (figure 5.2), the time for completion is 4 weeks, the contractor's programme shows him finishing in 4 weeks and he actually does finish in 4 weeks. This, even though the employer has delayed him for a week. There is clearly no need for any liquidated damages to be deducted and all respondents agreed on this. Although no extension of time is required to defray deduction of damages, almost a half of the Engineers and two fifths of the Contractors felt that one should be awarded. Concerning whether overhead costs should be paid to the contractor, there was a majority of both Engineers and Contractors who favoured paying overhead costs for 1 week.
This case has parallels with both question 29 and question 20, both previously discussed. In question 29, even though the contractor had allowed for the amount of overheads he eventually had to pay, the consensus seemed to be that he ought to be reimbursed the overheads for any time the employer had delayed him. This result is repeated here. In question 20, most respondents felt that an extension of time should be awarded rather than simply recognizing a delay for which the employer was responsible. In somewhat similar circumstances, but this time where there is obviously no need for an extension of time, a number of

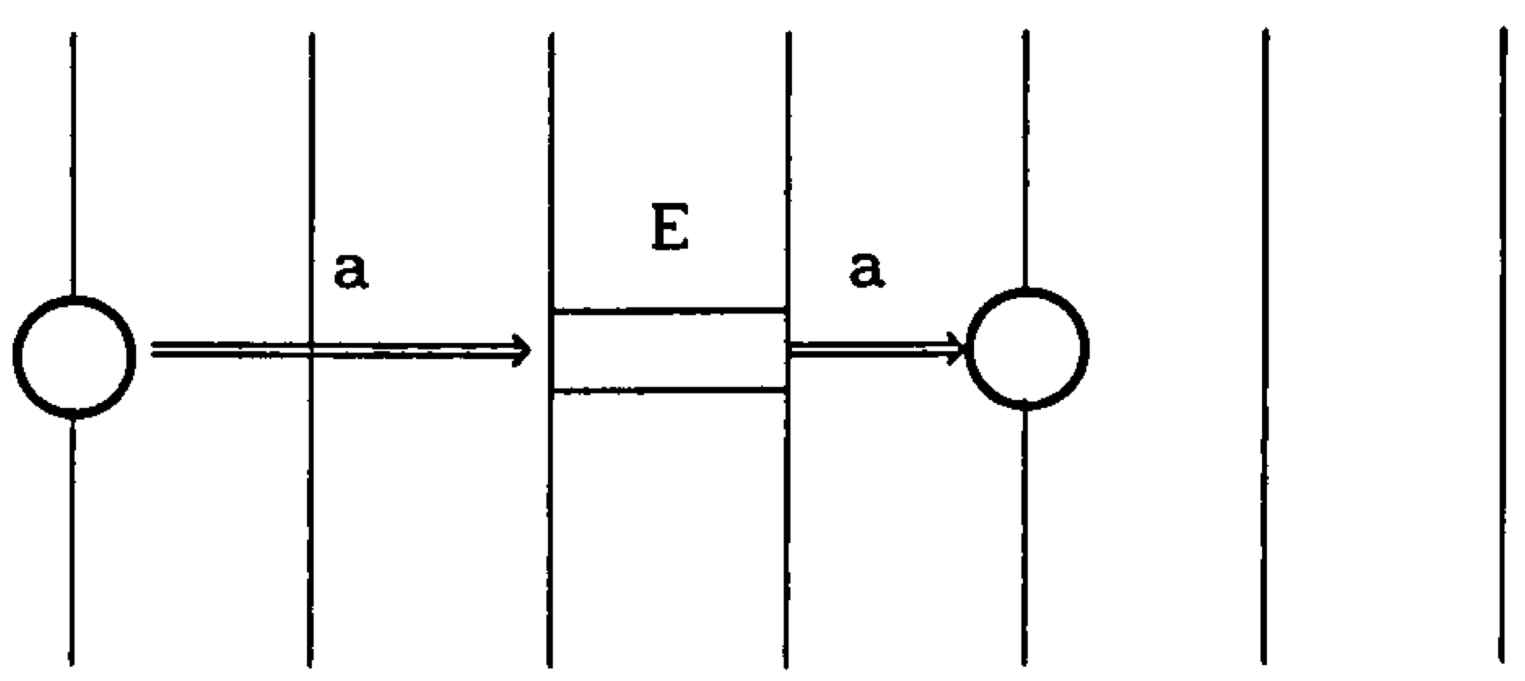
PLANNED



weeks

The whole project consists of one activity 'a'

ACTUAL



At the end of the 2nd week work is suspended for 1 week (employer-responsible delay), but the contractor still completes on time.

	No. of weeks	ENGINEER ALL	ENGINEER Eng	ENGINEER R.E.	CONTRACTOR ALL	CONTRACTOR Agent	CONTRACTOR QS
Liquidated Damages	0	11	7	4	11	5	6
	1						
	2						
Extension of Time	0	6	3	3	6	3	3
	1	5	4	1	4	2	2
	2						
Recovery of O/heads	0	3	2	1	2		2
	1	8	5	3	9	5	4
	2						

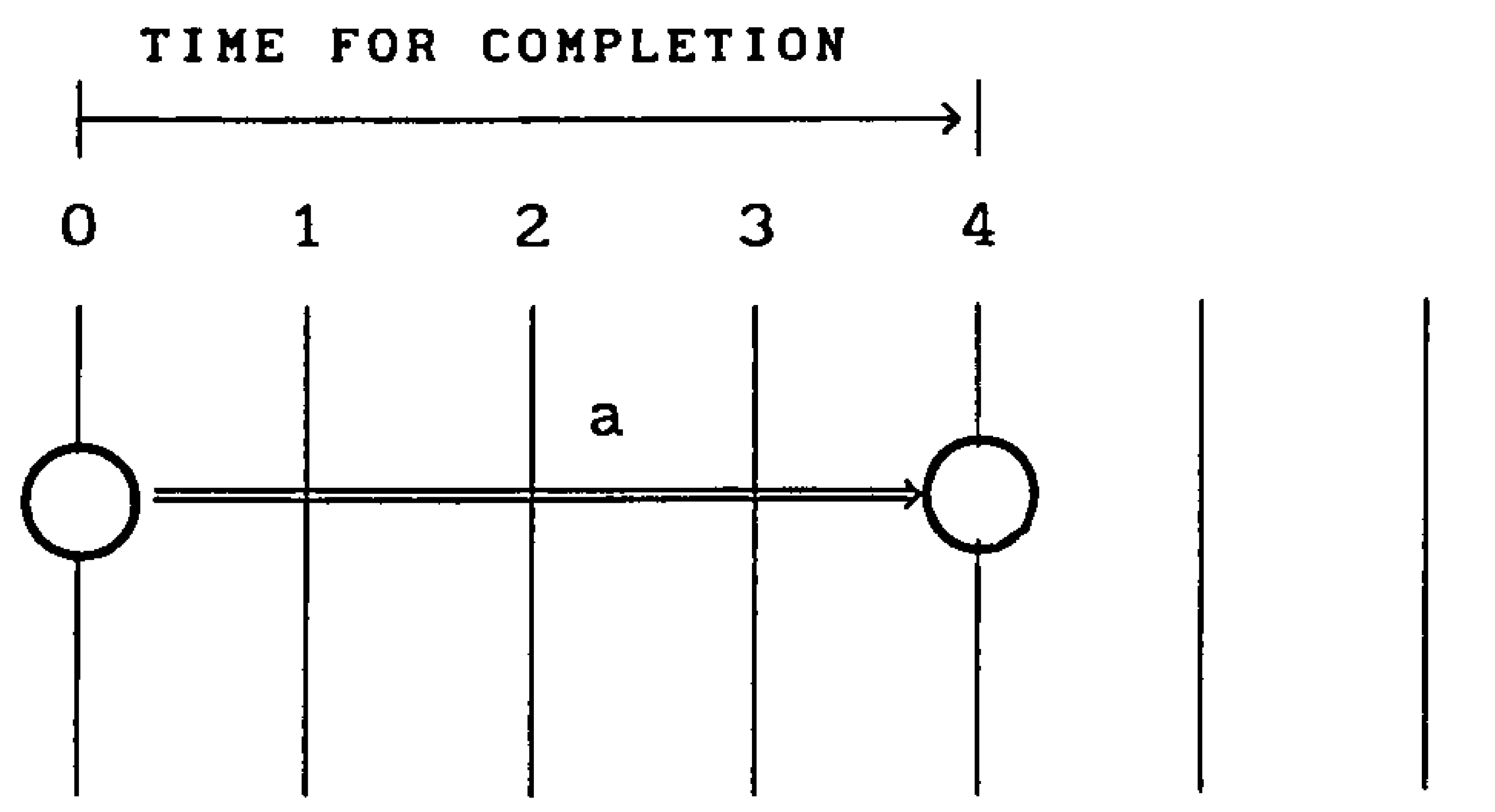
Figure 5.2 Question 35(E): diagram A

interviewees still wanted one to be awarded. There appears to be a linkage in many of the respondent's minds between such delays and extensions of time. This ignores any possibility that overheads might be recovered without such an extension.

The remaining diagrams show a variety of ways in which overlapping delays might affect a project's outcome. The first, diagram B (figure 5.3), contains two delays type E and C both affecting a single activity 'a'. Almost all replied that no liquidated damages should be deducted with a majority of both Engineers and Contractors recommending a 2 week extension of time. The position on the recovery of overheads, however, was not so clear cut. Most Engineers felt that overhead costs should be paid for one week only, while 6 out of 10 Contractors felt that two weeks overhead costs should be payable. The Engineer's view in this case is identical to the solution that would pertain adopting the U.S. approach to these matters. That is, that a 2 week extension of time should be awarded, but with overhead costs payable for only one of those weeks. Further investigation of the Contractor's response shows that the quantity surveyors' responses were equally split between 1 and 2 weeks overhead recovery, with the agents being bullish about their rights to 2 weeks overheads.

Diagram C (figure 5.4) is similar to diagram B, involving two delays type E and C, although this time they are

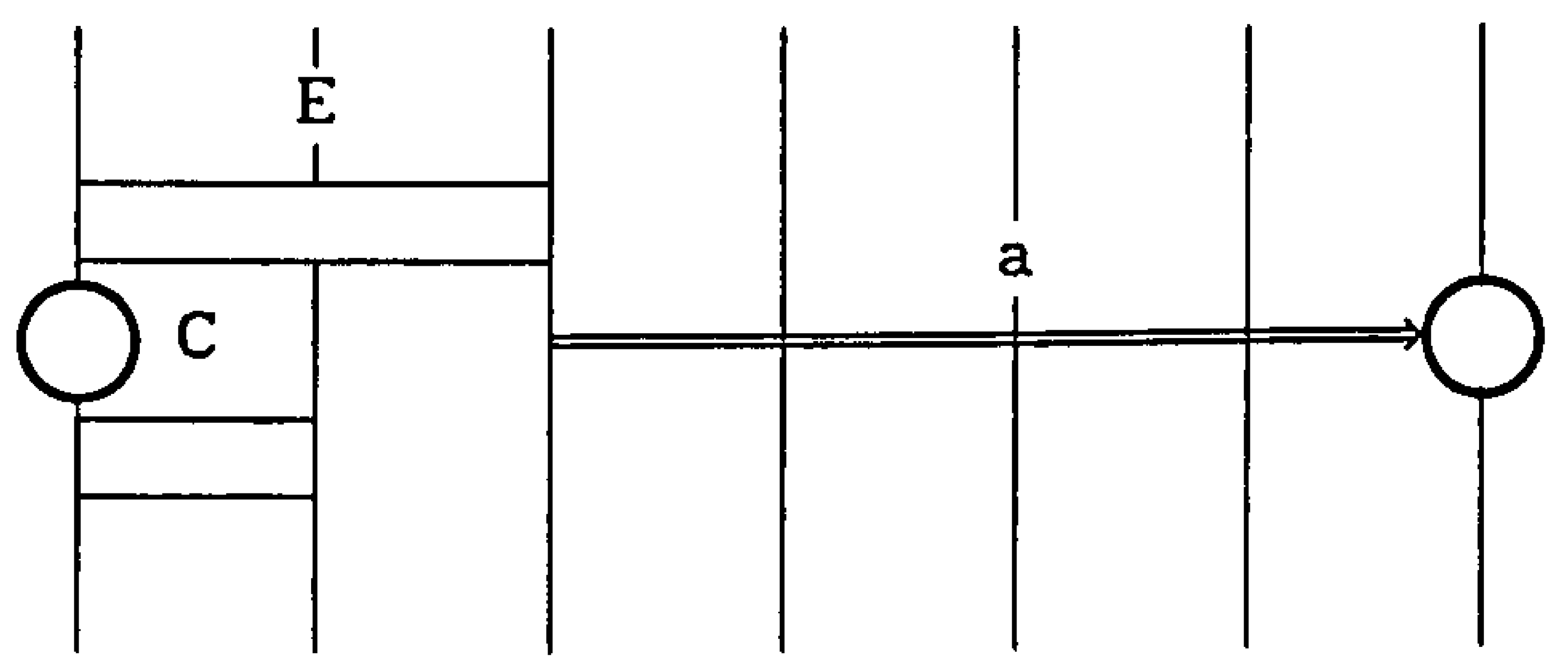
PLANNED



weeks

The whole project consists of one activity 'a'

ACTUAL



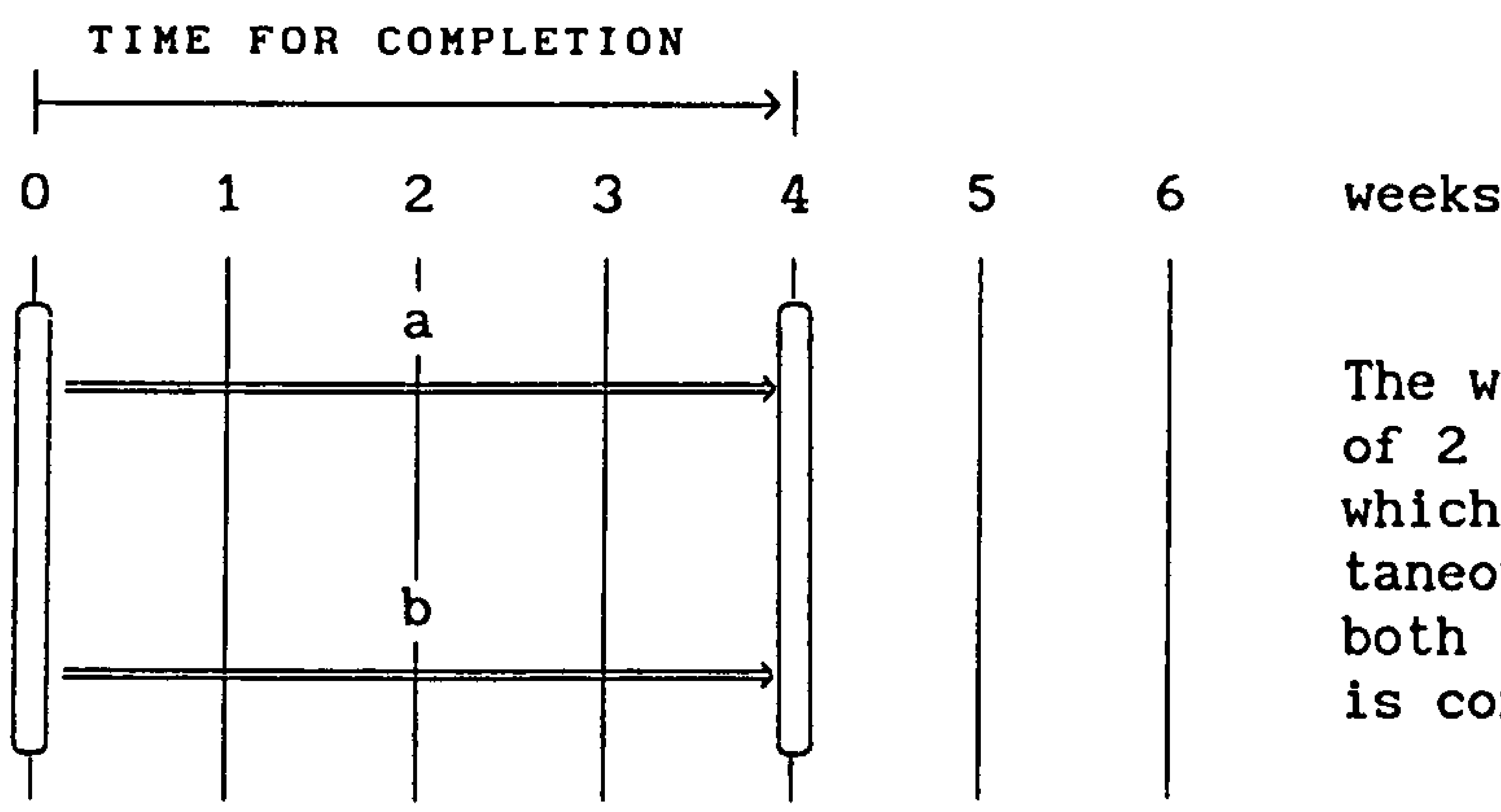
Work cannot start until the end of the 2nd week when the site becomes available. However, the contractor was not ready to start until the end of the 1st week.

The project is completed 2 weeks late.

	No. of weeks	ENGINEER ALL	ENGINEER Eng	ENGINEER R.E.	CONTRACTOR ALL	CONTRACTOR Agent	CONTRACTOR QS
Liquidated Damages	0	10	7	3	10	5	5
	1	1		1	1		1
	2						
Extension of Time	0						
	1	4	2	2	2		2
	2	7	5	2	9	5	4
Recovery of O/heads	0						
	1	8	6	2	4	1	3
	2	3	1	2	6	3	3

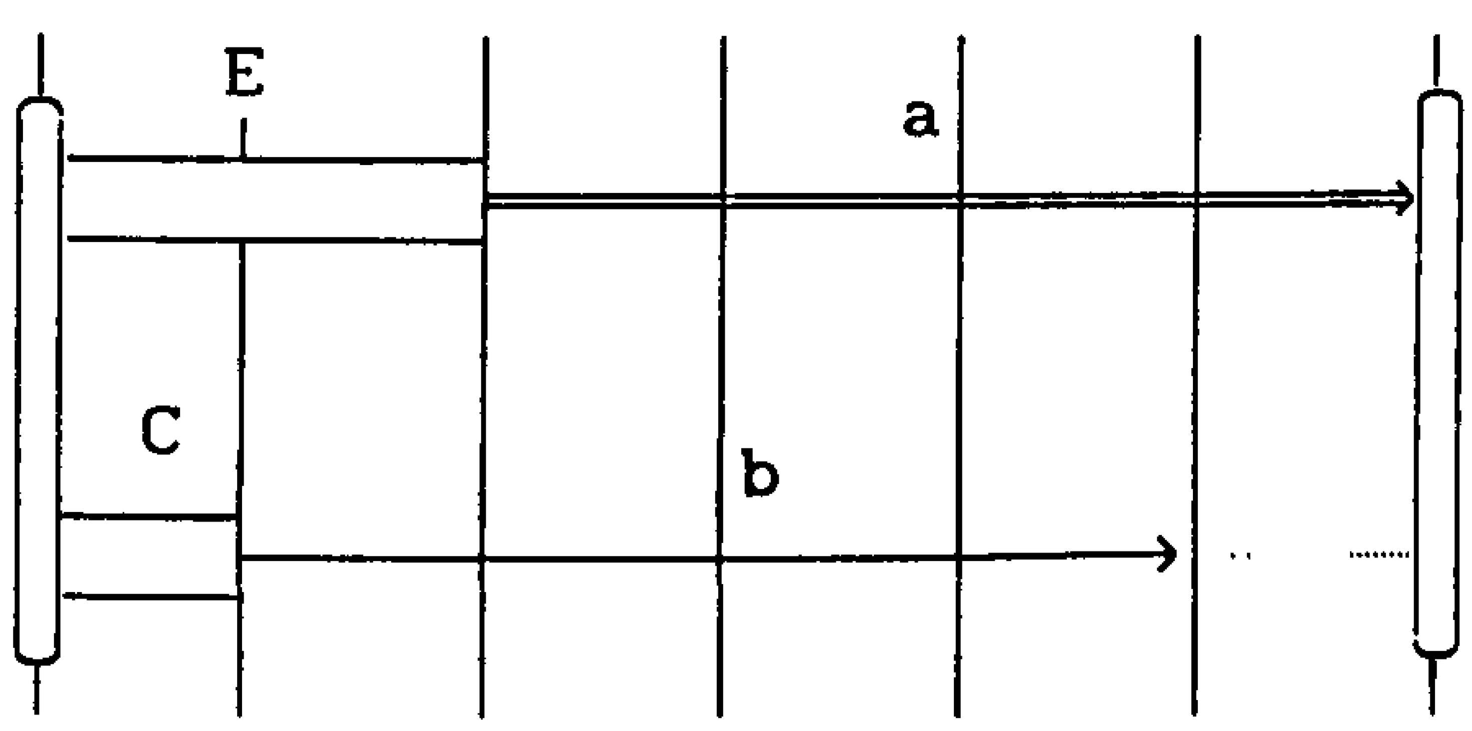
Figure 5.3 Question 35(E): diagram B

PLANNED



The whole project consists of 2 activities 'a' and 'b' which can proceed simultaneously. When they are both complete, the project is complete.

ACTUAL



Delays due to the employer (E) and the contractor (C) result in the project being completed 2 weeks late.

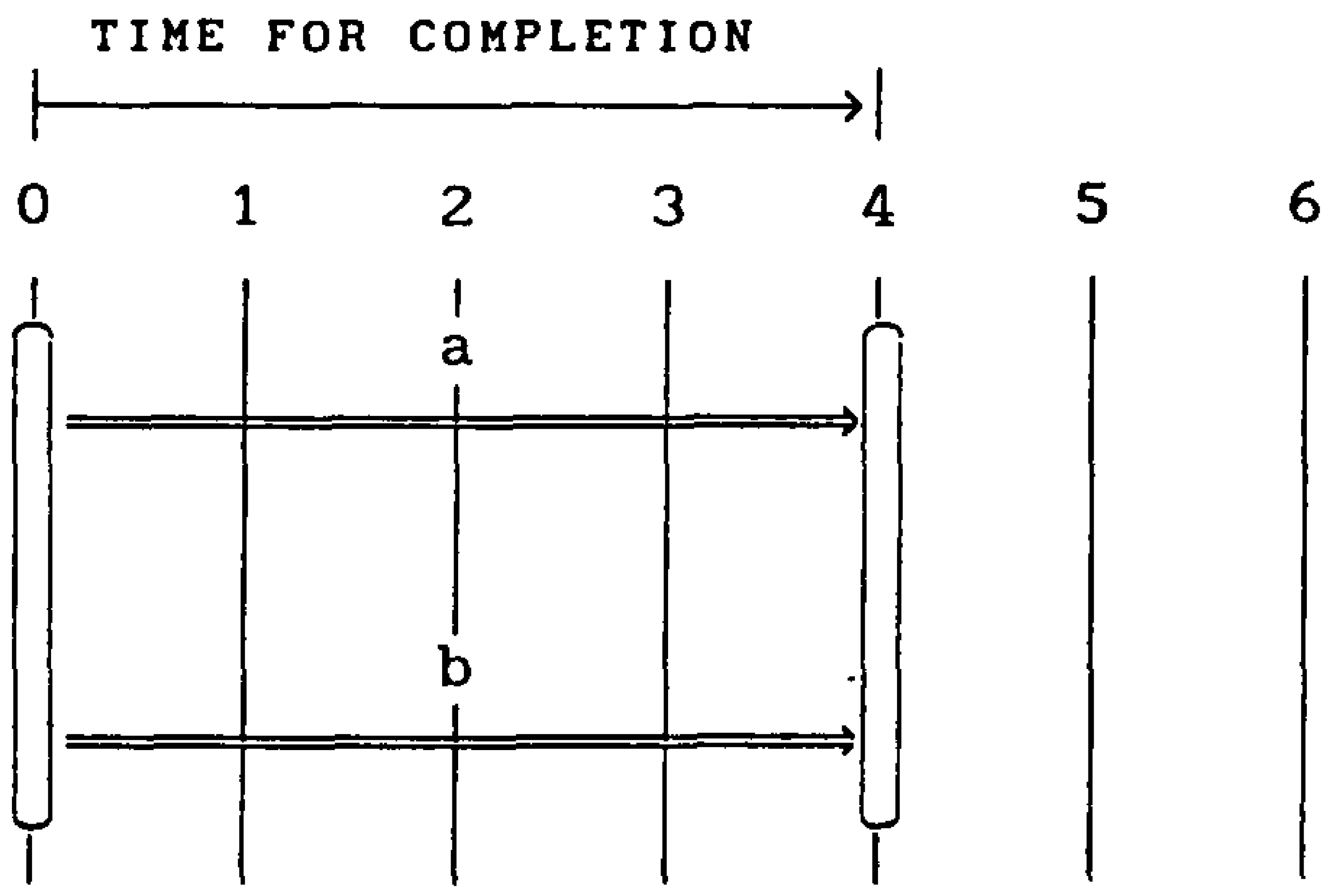
	No. of weeks	ENGINEER ALL	ENGINEER Eng	ENGINEER R.E.	CONTRACTOR ALL	CONTRACTOR Agent	CONTRACTOR QS
Liquidated Damages	0	11	7	4	11	5	6
	1						
	2						
Extension of Time	0						
	1	1	1		1		1
	2	10	6	4	10	5	5
Recovery of O/heads	0						
	1	3	2	1	1		1
	2	6	3	3	8	5	3

Figure 5.4 Question 35(E): diagram C

affecting different activities. The delays are, in fact, on parallel paths. The response was unanimous that no liquidated damages should be deducted, and nearly so on the belief that a 2 weeks extension of time should be awarded. It was less conclusive concerning the amount of overheads that should be recovered, but most Engineers and Contractors still thought that these should be paid for 2 weeks. If an adjusted schedule was to be constructed for this situation, in line with the U.S. approach, by removing the employer-responsible delays, it would show that the contractor, in the absence of type E delays would not have been able to complete the project on time. He would be one week beyond the time for completion and thus should, on this basis, have 1 week of liquidated damages deducted. The other week should be covered by an extension of time for which overhead costs should be paid. Both Engineers and Contractors disagreed strongly with this view and seem to have simply identified the critical path and made their decisions based on the delays on that path alone.

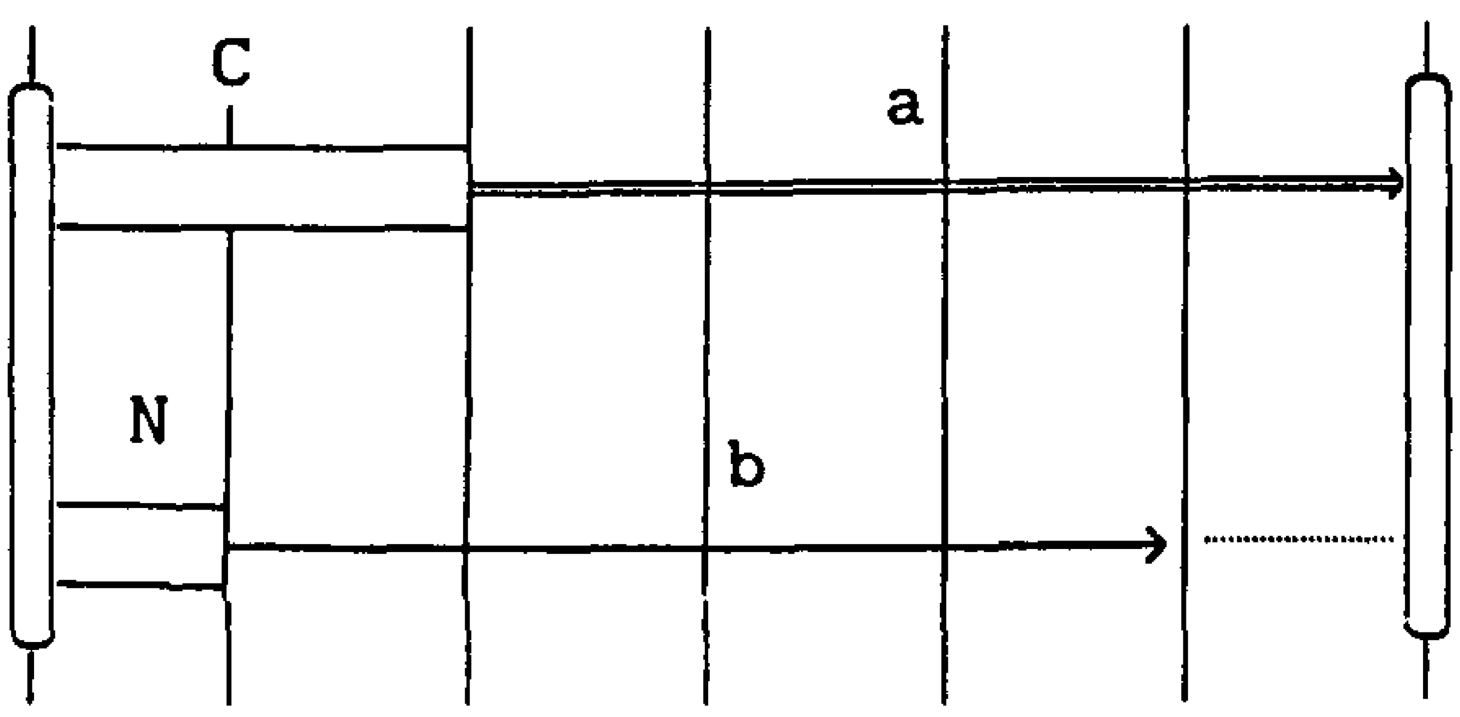
The last diagram, diagram D (figure 5.5), also has parallel delays, but this time they are of types C and N. Again a majority view can be defined for both Engineers and Contractors alike. That is that there should be an extension of time for 1 week, liquidated damages deducted for 1 week and no recovery of overheads at all. An alternative view would be that as the contractor by his own actions delayed the contract by two weeks, finishing two

PLANNED



The whole project consists of 2 activities 'a' and 'b' which can proceed simultaneously. When they are both complete, the project is complete.

ACTUAL



Delays due to the contractor (C) and to neither party (N) result in the project being completed 2 weeks late

	No. of weeks	ENGINEER ALL	ENGINEER Eng	ENGINEER R.E.	CONTRACTOR ALL	CONTRACTOR Agent	CONTRACTOR QS
Liquidated Damages	0				1	1	
	1	8	6	2	8	4	4
	2	3	1	2	2		2
Extension of Time	0	2		2	3	1	2
	1	9	7	2	8	4	4
	2						
Recovery of O/heads	0	9	6	3	11	5	6
	1	2	1	1			
	2						

Figure 5.5 Question 35(E): diagram D

weeks late, he should be totally responsible for this delay. By this argument he should have 2 weeks liquidated damages deducted. The respondents were, however, more generous than this. They clearly felt that the contractor should benefit from the fact that an 'act of God' type of delay would have prevented him from completing on time, had he not been delayed himself. Depending on which method of dealing with concurrent delays was adopted, the U.S. response on such an outcome would be either that recommended by the majority of respondents here, or the alternative view expressed.

In comparing the responses given by Engineers with those given by R.E.s, little difference in their overall attitudes to these problems could be distinguished. On the other hand, although there was no great gulf between the opinions of the agents and those of the quantity surveyors, the expectations of the quantity surveyors tended to be generally lower than the agent's expectations.

3. Claims Procedure

Under this heading are collected the responses to questions that aim to identify particular procedures adopted by both contractors and engineers in preparing and assessing delay claims. These range from questions to determine the philosophy adopted to prove the causal effect of individual delays on the completion of the project as a whole, to more mundane aspects of procedure. For example, there are questions dealt with here that aim to determine how the engineer/R.E. documents decisions on delay claims and also to determine exactly who makes the decisions on such matters.

Within the first category, that is the attempt to identify the philosophy or mechanisms used to prove or assess delay claims, three basic questions have been adopted. One of these (Q33), is addressed to the Engineers only, one is addressed to both Contractors and Engineers (Q26 (Contractor), Q34 (Engineer)) and the third is addressed solely to Contractors (Q39A). The first of these (Q33), comes straight out with the main question,'What procedure do you adopt for assessing the validity of a claim for an extension of time on a complex project?'. The responses received were varied, ranging from:

> 'Analyse evidence, compare with our records and make a decision based on those facts.'

to:

> 'Require demonstration that delay has occurred, secondly that delay was critical to completion date; gets very complicated - anything but straightforward.'

There was a general recognition of a need to check facts as proposed by the contractor with the R.E.'s records, but other points made were:

i) justifying that the delays couldn't have been expected;

ii) look at the claim as though you were making it;

iii) try to establish another 1 or 2 ways to evaluate the cost of the claim to get a feel for where the settlement figure should lie - then negotiate with the contractor;

iv) difficult to specify a general procedure - depends on how the claim is presented;

v) use programme, assess links between activities and take account of float;

vi) try to accept contractor's approach - if not, use own methods.

In the belief that this first question might not elicit responses that directly addressed the actual mechanism used to affirm or assess the impact of individual delays, a second more specific question was included. This was put to both Contractors and Engineers and asked,'How do you show that/decide whether a delay to a particular activity has actually contributed towards delaying the whole project?'. The responses of the Engineers will be dealt with first, followed by those of the Contractors.

Seven of the Engineers interviewed mentioned the critical path or critical activities in their replies, some of them recognizing that it may not always be easy to identify this path. Two respondents used the word 'shunting', referring to subsequent activities in the project being moved along by the effect of the delay in question. There was certainly a general belief that where this 'shunting' occurred on the critical path, that an extension of time might well be justified. Other comments made were:

i) need to check for float on path affected;
ii) possibility of stalling to see if path on which delay occurred is actually critical;
iii) CPM programmes appear when such claims are being made;
iv) use the programme as a basis, but then monitor actual activities and only agree payment if real delay occurs;
v) criticality is judged from understanding of sequence of activities;
vi) typically contractor identifies critical path - you check it.

The importance of critical paths and the shunting effect of particular delays on activities on such a path were also recognized by the Contractors who answered this question. There was, however, another important element reported by four of the Contractors that was not mentioned by any of the Engineers. This was the concept of 'plugging' delays into the contract programme to see their effect on completion time. Two of the four said that they would use a software package for this. This is particularly interesting as it begins to appear that the production of an 'as-built' programme is being described. However, on further examination, this was seen not to be the case. The Contractors who used this approach admitted that they would use the activity durations from the original programme for this purpose, and made no attempt to record actual durations of the activities. In fact, it was mentioned by one Contractor that he would extend actual delay durations used in this exercise to those that would have occurred had he not increased his resources to improve the situation. The Contractors explained their aim in using this approach as being to demonstrate to the employer their 'entitlement'. Having plugged in the delays to the initial contract programme in this way, they would expect to show a completion time beyond what they actually needed. The fact that they had managed to complete before this time, they would argue was because they had been particularly expeditious in carrying out the contract. This would then be followed, no doubt, with an expectation that the employer would pay them their costs, possibly with an element of profit.

In some circumstances, a large number of site instructions might cause considerable disruption to a contractor's performance. This might happen in such a way that it is difficult for him to isolate and deal with each delay individually. Question 39A described this scenario and asked Contractors how they would formulate claims in such a situation. Four out of the ten responses were that this would be dealt with as a combination of individual causes of delay; effectively saying that they would be able to isolate individual delay effects. The others recommended amassing information on the value of the instructions together with information on the contractor's total costs. By showing the monies spent compared with the anticipated spending profile, the Contractors aimed to show that the increased expenditure was due to the disruptive effect of the instructions.

In the second category of questions considered under this heading, two matters were investigated. Engineers were asked how they documented their decisions on delay claims, and both Contractors and Engineers were probed to identify the individuals in their organizations who took responsibility for dealing with such claims. In the first area, it might be expected that for a claim of any magnitude, a full report would be prepared to clarify the basis of decision-making. Such a report was confirmed as being produced in only 3 out of 9 interviews. The other Engineers interviewed said that they relied on handwritten notes on contract correspondence. As much clarification as possible was included in letters to the contractor or in file notes. It must be admitted that the difficulty of dealing with such claims would make it very hard to explain in a totally convincing manner just how the decision had been made. Of course, this may not be the reason for failing to produce a report, and it may simply be that a less detailed method of recording these matters is considered adequate.

The task of carrying out the detailed work involved in checking a contractor's delay claim seems to fall to the R.E. and his staff in most instances. However, the responses suggest that there will usually be an overview of any recommendation from the R.E. made by somebody in the Engineer's organization at a higher level. It should be remembered, of course, that the power to make decisions on these matters cannot be delegated to the R.E. under ICE5. A similar question was addressed to the Contractors, but this time the question asked who had the responsibility for deciding to proceed with extension of time claims. The responses in this instance depended very clearly on whether an agent or a quantity surveyor was being interviewed. Four out of five agents said that the decision was taken by the agent, subject to approval by the contracts manager. Three out of six quantity surveyors interviewed confirmed that it was the area or project quantity surveyor who made this decision. The other replies were that a director or associate director made this decision with input from agent or quantity surveyor.

4. Claims - miscellaneous

At the heart of the critical path method of planning is the idea that having arranged a network of activities that represents the construction of a project, that a longest path through this network can be found that will dictate minimum project time. This, of course, is the critical path. At the planning stage, it is easy to identify this path (there may be more than one), and to recognize its/their significance. As soon as the project begins, this simple model of progress is likely to be found wanting. Activities will not always start and continue uninterrupted to completion, overlapping of activities not shown on the plan will occur and, of course, there will be delays from the various sources. Can the essential critical path for the project still be recognized and identified in such circumstances? There will obviously be some projects that by their nature consist of one main sequence of activities, and where the critical path is likely to be unchanging. However, where the network is more complex with a number of parallel paths, identification of any critical path may well be more difficult.

With this understanding of the real situation confronting site engineers, two questions were put to both Engineers and Contractors. These were: to find out whether critical paths usually changed on their projects and whether they could always identify the critical path for the finished job.

The responses to the first question were inconclusive.

Three Engineers said that the critical path usually changed while five others said that it did not. Comments varied from,'very rare', to 'often - not unusual'. In complete contrast, nine Contractors confirmed that the path did usually change, with only one responding 'don't know'. Their comments were 'often' and 'sometimes', with one interviewee saying he could not think of a job where it didn't change. It is clearly possible that the Engineers and Contractors have been involved in different types of schemes and that this is the reason for the mismatch in their replies. However, as most of them were relying on their experiences on a number of past schemes in answering the questions, this would seem to be an unlikely reason. Other explanations of this occurrence are possible. It might be that the two parties have different conceptions of what comprises a critical path on a live project, or simply that they have different information available to them. If the critical path is not identified on the contract programme, as it often will not be, then how is the engineer to know whether it has changed?

For the second question,'Are you always able to identify the critical path for the finished project?', there was a reasonable consensus between Contractor and Engineer. A majority of both felt that they would be able to identify the critical path and a number of interesting comments were made, as follows:

Engineer:

> 'Yes (I am able to identify the CP), but it doesn't mean to say that I do.'

> 'Often with difficulty - you can never be certain of analysing the real critical path.'

Contractor:

> 'With difficulty - you are always going to have a critical path through each structure (when more than one is built at once).'

> 'You may have more than one.'

The first comment from the Contractors, above, seems to suggest a particular way of looking at the real critical path. Rather than a path that is the longest through the network as a whole, this Contractor would appear to identify important paths through each main part of the network. For him, achievement of each section is critical to the completion of the project as a whole. The fact that this is not in line with our normal understanding of the critical path perhaps highlights a need to define better what we mean by that path, when it refers to a live project.

The last question under this heading was also addressed to both Engineers and Contractors. This was,'Are you aware of the use of as-built CPM schedules to validate extension of time claims in American court hearings?' Of the 22 replies, there were 17 unconditional no's, 4 conditional no's and only one 'yes'. One Contractor who replied 'no', added that he used as-built programmes; this was the same Contractor whose approach was described in section 3 as attempting to demonstrate 'entitlement'. The as-built programme as he understood it made no attempt to incorporate actual activity durations, simply using the durations from the initial contract programme. The responses here were a clear indication of the fact that the established procedure adopted in the U.S. is almost unheard of in this country. From the replies in the previous section, it appears that this may also be true of the philosophy that underlies the U.S. approach.

This section on the preparation and assessment of claims is by far the longest in this chapter and a summary of the main points will now be attempted. Rather than summarize under the subheadings adopted for this section, the material will be summarized under two main themes. These are: the attitudes to particular claims situations and the mechanisms that are adopted in preparing and assessing those claims.

Under the first heading, a number of claims situations were identified and the way in which the respondents reacted to these will now be considered.

i) *When the contractor is delayed by the employer and yet* *still manages to complete within the original time for completion.* Both Engineers and Contractors strongly supported the view that the contractor may have a claim for extended overhead costs. This situation was described in question 28 and question 35 (diagram A).

ii) *What kind of claim should the contractor make in situation (i), above?* The dilemma concerns the fact that the contractor wishes to lodge a claim to recover his overhead costs and yet does not need an extension of time. Question 20 addresses this problem but does so part-way through the contract. In question 35 (diagram A) it is clear that no extension of time will be needed, whereas in question 20, the outcome is not known at the time of the decision. In both instances, several respondents recommended that an extension of time should be considered: just under a half where the outcome was fully known and the majority where the contract was incomplete. There appears to be a belief amongst some that an extension of time needs to be awarded before a claim for overheads can be considered. From the responses, we can see that this uncertainty has lead to some odd practices being adopted. One Engineer said that when a contractor's programme showed completion before the time for completion, that his chosen completion date then became the new time for completion. Also, one contractor identifies any time between his chosen time for completion and the actual contract completion date as 'period for use by the contractor for circumstances other than entitlement to extension of time.' It appears that some clarification is needed in this area if such questionable practices are to be controlled.

iii) *When the contractor is delayed by the employer and yet still manages to complete within his own planned time for completion.* This scenario was covered by questions 29 and 35 (diagram A). In both, Engineers and Contractors were quite strongly in favour of accepting that the contractor may have a claim for extended overheads. They clearly rejected the argument that the contractor had not suffered any damages because he had expected to pay the amount of overheads that he finally paid.

iv) *When two concurrent delays type E and C hold up a single activity.* For the period of overlap of these two delays, it seems that most Engineers felt an extension of time should be awarded but without costs. In contrast, a small majority of the Contractors would also seek overhead costs for the overlapping week.

v) *When two parallel paths through the project are held up by delays type E and C.* In this scenario, the path with the type E delay was dictating the completion time, while the other path, including the delay type C, had some float. Both parties strongly favoured awarding two weeks extension of time and were quite strongly in favour of awarding two weeks overhead costs. No attempt to recognize a period in which both type E and type C delays were operating seems to have been made. Also, the respondents clearly had no wish to see the contractor suffer, even though without the type E delay, the contractor could not have completed on time.

vi) *When two parallel paths through the project are held up by delays type C and N.* Here the path with the type C delay dictated the completion time, while the other path, including the delay type N, had some float. In this case there was quite good agreement on the proper outcome. Surprisingly, however, some allowance was certainly being made for the concurrent delays on separate paths, as an extension of time was recommended for one of the weeks. This would clearly defray the need for the contractor to pay liquidated damages for one week. The overall impression from both this case and the previous is one of being generous to the contractor.

Many permutations of different delay types in parallel or in series are possible, and further investigation of these may well be fruitful. For the current study, however, it was felt that the four diagrams used were quite enough, given the number of other areas being studied. If further work was to concentrate solely on this aspect, a greater understanding might result.

Under the second heading in this summary, the mechanisms or procedures adopted in preparing and assessing delay claims will be dealt with. The basic approach adopted by most Engineers in assessing these claims was as follows:

i) check the facts of the contractor's submission;
ii) identify or verify the critical path;
iii) check whether the delays on that path have had a shunting effect on the activities;
iv) if some of the delays on the critical path would cause an extension of time, then an extension of time may well be justified.

Similar views were expressed by contractors concerning the ways in which they would try to prove their rights to an extension of time. A few of them sought to demonstrate 'entitlement', as previously described. It seems clear that, apart from the 'entitlement' method, the interviewees tended to deal with these problems on the basis of the critical path alone. Other paths through the network were not considered. This view is supported by:

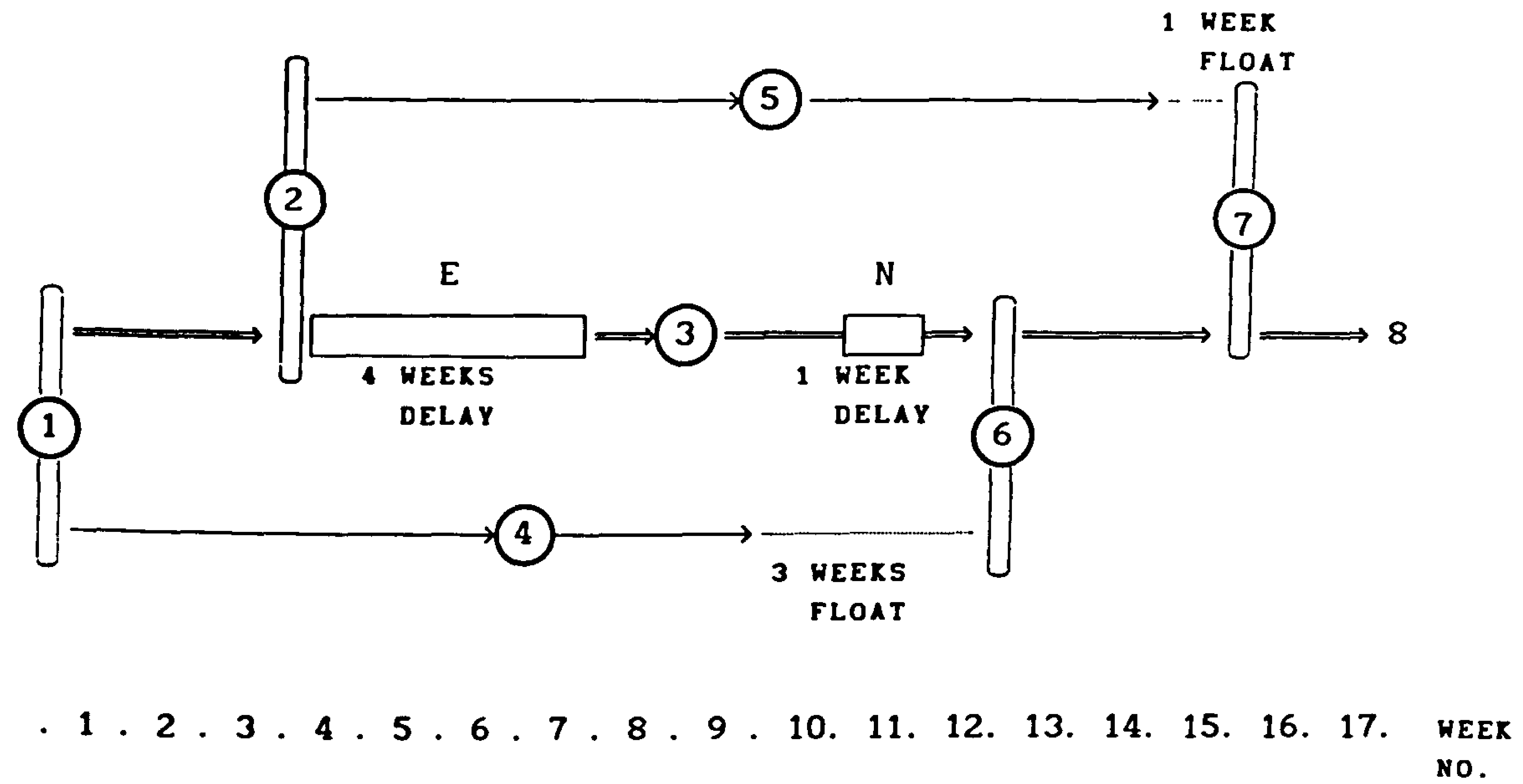
i) the ways in which the interviewees described their methods;
ii) the results of question 30, where no comments regarding parallel paths were made;
iii) diagram C of question 35, where almost all respondents would award a 2 week extension of time with no liquidated damages deducted, even when the contractor could not have completed in time in the absence of

type E delays;

iv) the fact that there is virtually no awareness of the U.S. approach to these matters.

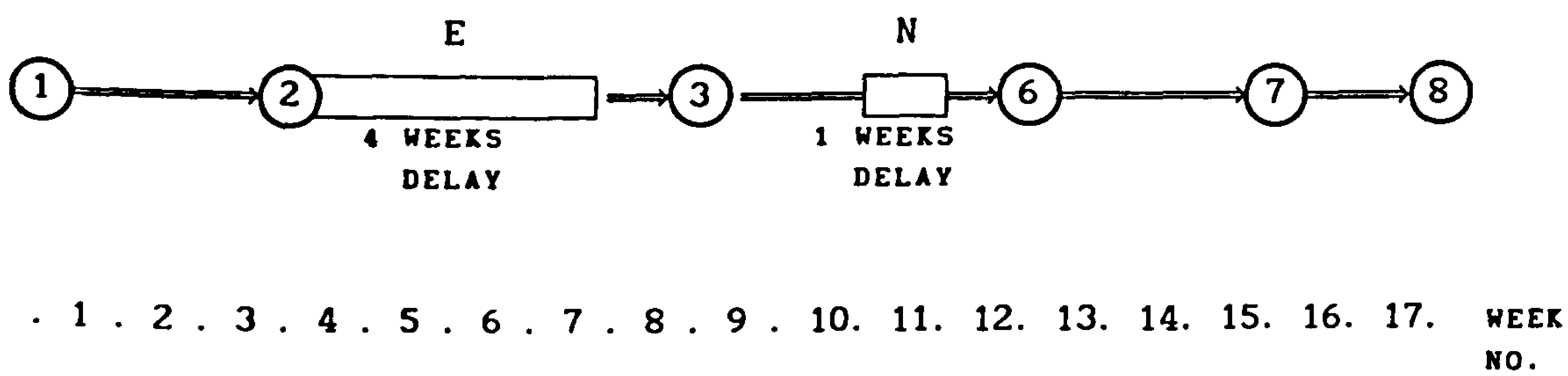
If other paths through the network are not identified along with the critical path, then a dubious assessment of the delay claim may result. Figure 5.6 has been prepared to clarify this point. We see from this figure that the judgement we would make if we only consider the critical path may be quite different from the judgement made in the light of the 'as-built' network.

The foregoing discussion assumes that a critical path on a live contract can be identified and that the term has some meaning in this context. At the planning stage of a project, the critical path is easily identified as the path with no float when minimum completion time is enforced. However, even with good, accurate records of the activities in the contract, the critical path may still be difficult to identify. When the contractor may start an activity, stop for a while and then restart, how are we to view this gap in the activity's progress? Is it float? If so, there may be no path through the network that does not have some element of float within it. The questions in the questionnaire concerning the critical path produced some odd results. There was a decided disagreement between the Engineers and the Contractors as to whether this path usually changed during the course of the contract. On the



a) PROBABLE JUDGEMENT WITH SIGHT OF FULL AS-BUILT NETWORK:

1 week extension of time with overhead costs



b) PROBABLE JUDGEMENT WITH SIGHT OF AS-BUILT CRITICAL PATH ONLY:

5 weeks extension of time; 4 with overhead costs

Figure 5.6 Diagram to demonstrate the need to consider paths other than the critical path question of ability to identify the final critical path for the contract, however, both parties confirmed themselves able. Other comments expressed while answering these questions gave the impression that either this was not always easy to do, or that the respondents may not have a common understanding of the critical path in these circumstances. The suggestion then, is that it may well be necessary to provide an alternative definition for the critical path when it relates to a live contract. This problem will be addressed in the next chapter.

For disruption claims, caused by a large number of site instructions, two main responses were given by the contractors interviewed. One response was that this was not a special problem and could be dealt with in the same way as other delays. The other response was to amass information on additional costs together with information on the sources of disruption. By showing these causes of delay and purported effects of delay the contractors hoped to convince the employer to pay their increased costs. The second method is recognized in the literature and yet fails to demonstrate any link between cause and effect. It could be argued that if some contractors are able to cope with these situations then others should also be able to manage. The excuse for adopting a less convincing approach to these problems is undermined.

F Miscellaneous Matters

(Questions 46 and 48 from the Engineer questionnaire and questions 38 and 40 from the Contractor questionnaire refer)

Two questions, both addressed to Contractors and Engineers, did not fit readily into the categories already discussed in this chapter, and will be dealt with here under miscellaneous matters. The first question concerns whether network analysis software is available for use on the respondent's construction sites and received a markedly different answer from the two parties. Most of the Contractors either had a program available or had access to one at their head office. In contrast, most Engineers did not provide such software on their sites although two firms said that on larger sites it would be available. This result might have been expected. Although the engineer is very concerned with matters of control, as previously discovered, it is the contractor who needs to exert that control and must be kept up to date with current progress. It is also the contractor who may wish to consider revised methods of construction and will want to know their effect on project completion. However, to some extent this is speculation, as no questions were included to determine quite what the programs are used for. Areas hinted at in previous questions include: demonstrating 'entitlement' to extra costs due to delays, and use as a cost model. Both uses were mentioned by Contractors.

The second question, which was the last one on both questionnaires, asked if there were any questions that the interviewees thought should be included in the study. Hopefully, the most important matters had been incorporated, but it was felt to be worthwhile to try to identify other areas of concern. Two such areas, highlighted at the pilot stage, were actually incorporated into the main questionnaire. The responses tended to be in the form of problem areas rather than particular questions and were as follows:

ENGINEER:

i) how to improve the claims situation on site;
ii) the contractual significance of weekly programmes;
iii) the effect of personal attitudes on assessing awards;
iv) the area of costs and rates;
v) anticipation of problems;
vi) are details of resources requested (included);

CONTRACTOR:

i) dealing with the effects of disruption (included);
ii) how to learn from past experience of programme not living up to requirements for better input to next programme;
iii) the contractual significance of programmes at tender stage;

iv) more emphasis on control - would you like a copy of the findings?

v) the importance of negotiating and presentation skills in presenting claims;

vi) the problems of management contracting;

vii) do firms use specialized companies to recover claims?

viii) firm's reputations in terms of claims aggressiveness;

ix) dealing with one-off personalities.

It could certainly be argued that points (E iii), (E vi) and (C i) are covered to some extent by this study and that one of the prime aims is to provide help in the area described in (E i). Equally, points (E iv), (C iv) and (C vi) have been purposely avoided. This still leaves a number of areas of interest that have been identified and have not been dealt with here. As previously stated, it is believed that most of the fundamental issues have been addressed, but accepted that not all the ground has been covered.

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

The principal aims of the work carried out for the first part of this thesis have always been twofold. Initially, the wish was to identify current practice and common attitudes in the use of contract programmes. This ground was covered in chapter 5. The intention, however, was always to use this information to make recommendations that will hopefully promote good practice in the future. It is in the current chapter that this second aim will be addressed. Working from three main sources of information, important areas will be addressed and methods and procedures advocated. These three sources are as follows:

i) the review of the literature on this subject as described in chapters 1 and 2;

ii) the results of the questionnaire survey conducted as part of this thesis and recorded in chapter 5;

iii) a diary of ideas kept by the author that developed throughout the study period.

The results of this process will not be in the form of detailed specification clauses that can be incorporated directly into a set of contract documents. Rather, it is intended to establish sensible principles from which those clauses might be written. The final section deals with the author's recommendations for future work. The main areas to be covered are thus as follows:

A The format of the contract programme

B Checking the contract programme

C Validation of delay claims

D Recommendations for future work

These will each be addressed in turn. There are other matters on which some comment will be made in this chapter, but these do not fall into the category of recommendations. They are, in fact, conclusions and relate to two main topics. These comprise the findings emerging from the questionnaire work and the discrepancy between the U.S.A. and the U.K. in their approaches to the area of delay claims. The first task, however, is to deal with the recommendations.

RECOMMENDATIONS

A The format of the contract programme

From the work on this subject recorded in chapter 5, a confused picture of current practice in the U.K. is identified. Some engineers clearly feel no need to prescribe programme format, while others prescribe to ensure that the contractor uses CPM. The new specification clause in the Notes for Guidance on the Specification for Highway Works requires that CPM be used, but allows bar chart or network diagram format to be used for presentation. It is clear from the results that in the absence of any required format, bar charts, linked bar charts or sometimes time/distance charts are favoured by contractors.

In the U.S.A., the literature reveals a completely different picture. A number of very long and complicated clauses from various contract conditions are identified and discussed. These clauses attempt to cover every aspect of the programme format, sometimes even requiring that the contractor retains trained site staff with sole responsibility for monitoring progress and updating the programme as necessary. A network analysis system is usually required. However, there is also evidence of a backlash against these very demanding specification clauses. Laurence Schor (32) writes that the Association of General Contractors (U.S.) warns owners to be careful when specifying CPM. They say that it can remove the scope of bidders and cause confusion, misunderstanding and hard feelings.

If good decisions are to be made on these matters, three important points need to be kept in mind. The first is that the engineer must demand a programme that satisfies his own requirements. To do this, he must be aware of the various uses that might be made of the programme and ensure that the programme produced is adequate for these uses. Secondly, there is a need to understand the way in which the contractor is likely to prepare his programme. In particular, it should be recognized that activities that otherwise would be non-critical may have been scheduled on the basis of optimizing resource usage. Disturbing this optimum schedule may affect the contractor's overall costs. The last point is that any constraint on the programme format should be limited. Only essential requirements should be demanded, and these should wherever possible still aim to allow the contractor maximum freedom.

The principal concerns under this heading are seen to be as follows:

1 The planning system used by the contractor
2 The form in which this plan is presented to the engineer
3 The level of activity used in this plan.

These will now be dealt with in turn.

1 The planning system used by the contractor

For small straightforward jobs where all the activities can be easily identified and the essential logic defining the dependencies between activities is simple and clear, there may be no need to use a network-based plan. Having drawn a bar chart schedule for such a job, the logic should be clear to all. Such projects will certainly exist in civil engineering but they will typically be limited to those with a low tender value. Even some quite small projects may involve a complex sequence of operations. These may have several activities capable of being carried out simultaneously and with complex interactions between parallel paths. Only experience can be expected to guide the engineer in identifying these simple schemes. For all others it is recommended that the contractor is required to use a network-based planning system.

There are three main reasons for making this recommendation. Firstly, the engineer will want to ensure that the contractor has fully understood the complexities of the job. Unless the essential network restraining and ordering the sequence of activities is recognized, then no good understanding can result. The contractor's accurate representation of the network is thus an important step in illustrating to the engineer that the Works to be carried out have been properly comprehended. Secondly, the engineer's strong wish to assess progress, identified in the questionnaire survey, cannot be achieved without being aware of the network. If progress to date is to be translated into a prediction of likely completion time, the sequence of activities still to be completed from that date must be known. Only then can the engineer warn the contractor of any need to take action. The final reason for recommending that the contractor uses CPM relates to the assessment of delay claims. In the summary to chapter 5 section E, it is made clear that assessing a claim for an extension of time simply by investigating the delays on the critical path may lead to an invalid judgement. Actual achieved progress on other paths through the project also needs to be taken into account. This is especially important when the claim comes part-way through the contract. In this case, it will be essential that the contractor's expected progress beyond any delay is known, together with the likely progress on other paths through the project. Such information will only be available if the contractor has planned the job using a network-based system. To require that contractors produce their plans in this way should not be at all onerous to most contractors. The survey showed that almost all those interviewed used CPM for planning at least some of the time.

2 The form in which the plan is presented to the engineer

Having developed the project plan using CPM to the stage where the network of activities is well understood, the contractor must then make decisions when to schedule non-critical activities. Unless he does this, some activities will not have defined dates when they are to be carried out. The expectation is that the contractor will make these decisions after considering the resource demand for the project. He will chose a schedule for the non-critical activities that fulfils some objective concerning the demand for labour or another important resource. Having done this, he has effectively fixed the scheduled dates for all the activities in the project. For him, this schedule will then be the plan to which he intends to work and which he will wish to convey to the engineer. (All this assumes that the contractor's working plan is basically the same one he offers to the engineer. There are odd instances where it has been suggested that two plans may exist: one for the contractor to work to and one for submission to the engineer. Such practices are not dealt with here).

The formats that are available and that might be used for representing this plan are as follows:

i) bar chart;
ii) linked bar chart;
iii) time/distance diagram;
iv) CPM network;
v) time-scaled CPM network;

...and each of these will now be considered in turn.

i) Bar charts: the basic bar chart is an ideal method of representing a schedule of activities, by showing for each activity the start and end date. However, it does not attempt to show the network logic and thus alone only gives a part of the information that the engineer will want to know. Nevertheless, it is the format favoured by most contractors.

ii) Linked bar charts: this format incorporates the good qualities of the bar chart with an attempt to illustrate the network logic. Dependencies between activities are shown as links between the bars that show the scheduled dates for those activities. When two links coincide the distinction as to which activities the links are connecting may be difficult to see. There may also be problems in showing a link to an activity that does not begin at its earliest start date. For these reasons, it is considered that this format may well have only a limited use. If it is accepted that only some of the links be shown and not all, then this format may be acceptable, but this should not be the case for a contract programme.

iii) Time/distance diagrams: these are seen as most useful on linear projects, such as roadworks and pipe-lines. In essence, the same information as the bar chart is displayed, but here, the y-axis represents the length of the job. An activity is shown as a diagonal line where it involves work done over a distance, and the activity description is usually written over the top of the diagonal line. In this way, both distance and time are shown to scale, whereas with a bar chart, distance can only be referred to by a note in the activity description. These diagrams may be shown with or without links, but it will typically be difficult to show all links in such a diagram. There appears to be no software available that will draw such a chart and thus where they are used, they are likely to be hand-drawn and hand-labelled.

iv) CPM network: the logic of the project will be clearly demonstrated by this diagram, but the time element is not well served. If earliest and latest event times are shown, then these will relate to the start of the project at time zero, and will have to be translated into actual dates by working from that datum. It is also evident that such diagrams will not, of themselves, be able to show the scheduled dates that the contractor has selected for non-critical activities. A list of scheduled activity dates would be needed to do this. There are, of course, two basic sets of symbols that may be adopted for CPM: activity-on-arrow and activity-on-node. A contractor who uses one system may not wish to be forced to use the other. Yet, the specification clause in the Notes for Guidance on the Specification for Highway Works quite clearly expects any CPM to have been produced in activity-on-arrow format. To rely solely on a CPM network diagram as the complete representation of the project plan would thus be unwise. For those who do not understand the CPM methodology, little can be gleaned from such a diagram which thus becomes of limited value as a document for communicating information. Even those trained in CPM use could only identify the earliest and latest dates that an activity might start.

v) Time-scaled CPM network: this format incorporates both the logic of the project and a time-scale to allow the contractor to give specific dates to the various activities. As subsequent activities on a path through the network can be shown in the same line (unlike other time-scaled diagrams), this limits the number of links between activities that must be shown. Because of this a clearer and less cluttered diagram results. The major drawback seems to be that such diagrams appear to be virtually unknown in the U.K.. Certainly, none of the respondents in the questionnaire survey mentioned this format.

A common failing identified by engineers in the questionnaire survey when checking contract programmes was that they did not always appear too professional. Scruffy handwriting and mysterious dotted lines were sometimes in evidence. Unless the programme is to be requested as a computer-generated plot, it seems that acquiring full and accurate details of the network and the activities involved all in one diagram, may be difficult. Indeed, not all computer-generated diagrams are fully clear. This suggests that it may be sensible to allow the contractor to use a format that allows him to identify scheduled dates for all activities while the logic is provided in another form. This is quite simple to achieve.

If a serious approach is to be taken to the provision of the contract programme, then the engineer will want to receive sufficient detail to define: all activities; all scheduled dates; the complete network. All this information is most accurately conveyed in the form of a listing rather than a diagram. Using activity-on-arrow format, a list drawn up as figure 6.1 provides all the information that the engineer needs to fix the contract programme completely. Note that all dummy activities must be included. The main advantage of the information in this form is that it can be easily typed and thus all the detail will be clear and unambiguous: many CPM programmes will produce a listing in this form. If he wished, the engineer could input this data into whatever CPM software he had available and reproduce the contractor's plan on his own computer. In a similar vein, figure 6.2 shows the listing necessary to define a network that has adopted activity-on-node format.

With full details of the contractor's plan securely provided in this way, there will still be a need for some diagram to communicate to all levels, the scheduled dates for each activity. It may be that a bar chart is the best way to achieve this, but as the engineer has all the

Activity Reference	Description	Duration (days)	Scheduled Dates From	To
1 - 2	Set up site	4	3/06/91	6/06/91
1 - 3	Strip topsoil	5	3/06/91	7/06/91
2 - 3	DUMMY			
3 - 4	Bulk excavation	10	10/06/91	21/06/91
3 - 5	Fencing	8	10/06/91	19/06/91

Figure 6.1 Specifying programme using activity-on-arrow

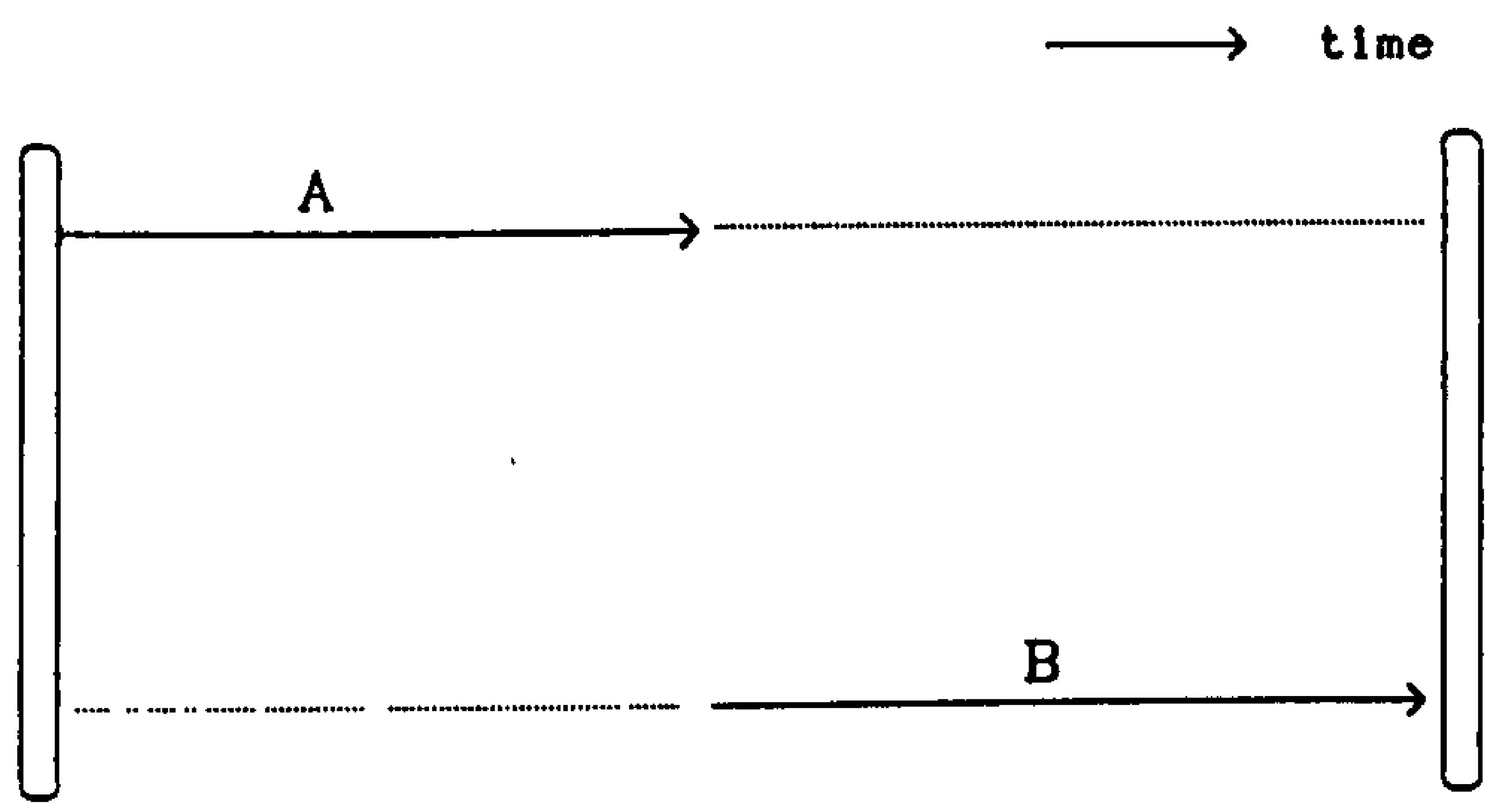
Activity Reference	Description	Duration (day)	Preceding Activities			
			direct	lead	lag	time
START		-	-	-	-	-
1	Set up site	4	START	-	-	-
2	Strip topsoil	5	START	-	-	-
3	Bulk excavation	10	1	-	-	-
			2	-	-	-
4	Fencing	8	1	-	-	-
			2	-	-	-
5	Excavate founds	4	-	3		5

Activity Reference	Succeeding Activities				Scheduled Dates From	To
	direct	lead	lag	time		
START	1	-	-	-		
	2	-	-	-		
1	3	-	-	-	3/06/91	6/06/91
	4	-	-	-		
2	3	-	-	-	3/06/91	7/06/91
	4	-	-	-		
3	-	5		5	10/06/91	21/06/91
4	-	-	-	-	10/06/91	19/06/91
5		-	-	-	17/06/91	20/06/91

Figure 6.2 Specifying programme using activity-on-node

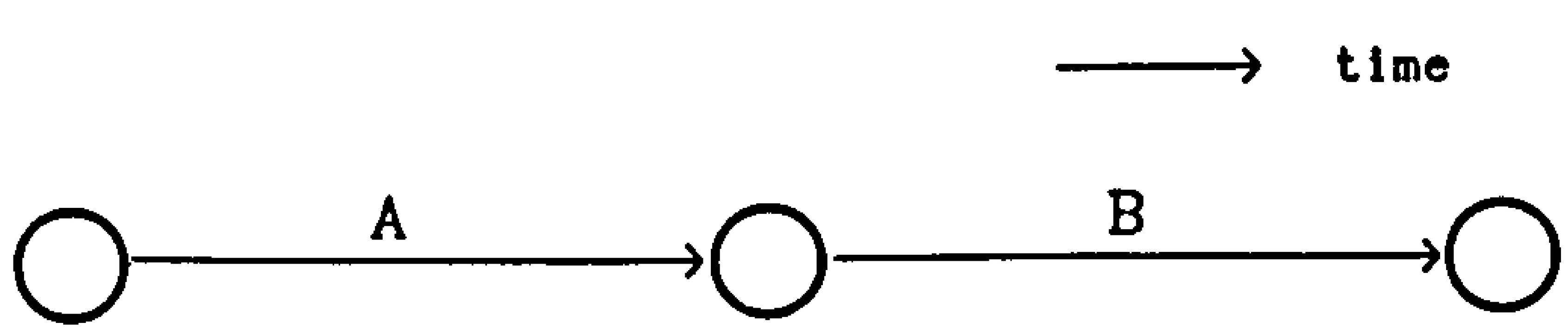
details already, he could easily allow the contractor to select the format.

Before leaving this section, it is important to spend some time considering the nature of the dependencies that the contractor has built into his plan. Some links between successive activities will be undeniable. The sub-base must be laid before the kerbs, columns must be constructed before the roof-slab etc.. Such links are often called 'hard' links; they define the essential logic. Dependencies that result from limitations on resources are typically called 'soft' links. An example of a soft link can be demonstrated if we consider two areas of cut, A and B, both to be excavated with the same plant. Here excavation of A would have to be completed before excavation of B began, because the plant would be moving from area A to area B on completion of excavation at A. It is certainly true that given sufficient plant it might be possible to excavate both areas at once, but the decision not to do so must rightly rest with the contractor. These soft links, where known resources are moving from one activity to another must be shown as normal dependencies in the network. If this is not done, and the dependency is enforced simply by scheduling, a false impression of the float in the network will result. This point is demonstrated in figure 6.3. Of course, if during construction it is found necessary to speed up progress, the soft link may be removed to allow both activities to



A network prepared in this way would permit A and B to be considered as simultaneous activities.

a) Relying on scheduling to enforce the logic



A and B clearly cannot be carried out simultaneously with this logic.

b) Logic properly represented

Figure 6.3 Need for soft links to be properly incorporated occur simultaneously. Exactly who should pay for any additional costs that stem from this would depend on which party had caused the acceleration to be necessary.

It must be realized that the recommendation that soft links should be incorporated as proper constraints in the network refers only to instances where identifiable resources are moving from one activity to another. This is not intended to refer to the case where activities have been scheduled to achieve some generalized resource objective: the provision of a smooth labour resource histogram, for example. In this instance, activities would have been scheduled on particular dates, not because specific resources had been planned to move from one activity to another, but simply to produce some optimum theoretical resource profile. If the scheduled dates for such activities were considered 'fixed' as a result of this exercise, it could be argued that the entire network was effectively critical. In such a case, any delay type E would immediately give rise to a claim that the whole project had been delayed. The question that must be addressed is whether this view of the contract programme is a valid one. It cannot be denied that in a perfect world, if the contractor was able to work to his resource-balanced programme, that this would probably minimize his costs. What should be realized, however, is that even in the absence of delays type E and N, the contractor would be most unlikely either to want to or to be able to follow his programme exactly. Indeed to insist on doing so might even cost him more. In the real world, the contractor's predictions on how the contract will develop will be wrong. He will not have identified the best way to carry out the work and decisions made part-way through the contract in the light of contemporary information will be more effective than those made at the beginning of the job. This means that the contractor is unlikely to work exactly to his own schedule. It would, therefore, seem unreasonable to expect the engineer to be bound by such a schedule. If the contractor wishes to claim that a delay type E, that has only used up available float, has affected his resource balance, he will have to prove the loss he has actually suffered. This he will not find easy to do.

3 The level of activity used in the plan

A programme to represent construction of a medium-sized project may look quite straightforward or very complex, depending on the level of activity that has been adopted in its preparation. At one extreme where activities are large, a general appreciation of the work involved can be readily acquired, although the underlying complexity is not grasped. At the other extreme, this complexity is fully revealed but effectively masks the broader view. Clause 14 of ICE5 makes little attempt to define the level of detail that should be adopted. It simply states that the programme should show the,'....order of procedure in which he (the contractor) proposes to carry out the Works..' The contractor is also expected to,'...furnish such further details and information as the engineer may reasonably require.' Those Engineers interviewed in the survey who rely on Clause 14 stated that they got an acceptable programme in this way. It is easy to see, however, that an awkward contractor would need to provide very little initial detail to comply with this requirement. Certainly one common failing of contract programmes reported in the survey was lack of detail and a broad brush approach being employed.

As previously stated, the engineer should be demanding the programme in the form that best suits his purposes, and it was revealed in the survey that two such purposes are paramount. The prime concern appears to be that the contractor's performance should be capable of being monitored, so that control may be exercised. The secondary concern is that the programme should facilitate the assessment of delay claims. What this may mean in terms of the activity detail that should be provided will now be considered.

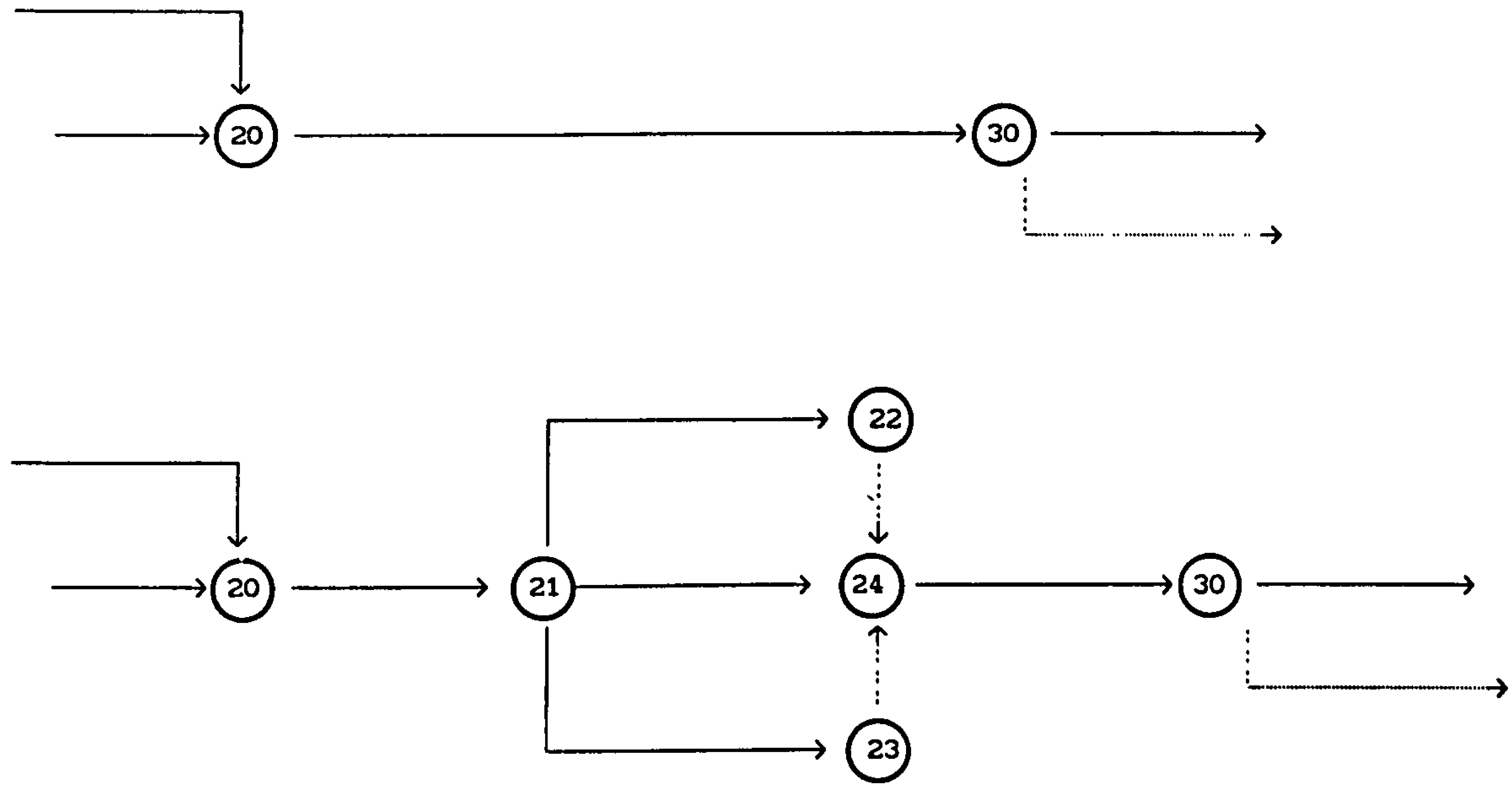
In truth, the engineer cannot usually exercise any direct control over the contractor's progress. What he will want to do, however, is to advise the contractor where he believes that progress is inadequate to achieve some required target date. This is usually done by assessing the contractor's progress at monthly intervals and commenting on the project's status at the monthly progress meeting. As control involves the comparison of actual progress against planned progress to decide whether action need be taken, an essential requirement is that actual progress can sensibly be assessed against the contract programme activities. Where these combine activities that are not necessarily carried out in parallel or use terms to cover a number of activities, this is unlikely to be possible. Examples of such combinations are common: 'site clearance and fencing' were combined on the programme for the site studied, and 'finishings' was used to describe soiling, seeding, white lining and carriageway works. Another way in which the contractor's sub-division of the project can hinder assessment of progress is in the use of activities with very long durations. In such cases, all the engineer can do is to assume that (say) a five month activity should be 20% complete after the first month etc.. Where the activity has not achieved such progress and the contractor has been informed, the response from the contractor may well be that there is a learning curve effect. That is that production at the beginning of the activity will be reduced while the workers iron out the difficulties. This assumes that in subsequent months more than 20% of the work will be achieved. This may, however, be said simply to divert attention from the current difficulty. Beyond these problems, it is clear that the activities used in the contract programme must include and relate readily to all recognizable parcels of work in the contract.

For a programme to be useful in assessing delay claims, it must be possible for the effects of any delay on subsequent activities to be realized. As much as anything, this means that all distinct activities must be shown. Where a delay has affected an activity that is not identified on the contract programme, the contractor at this late stage will have to show how this task ties in to the rest of the network. This will necessarily involve a change to the original network, albeit only to provide clarification. Two different attitudes towards making changes in the original contract programme have been identified in the literature. One of these is exemplified in the specification clause NG 1/13. In this clause, that states how the contractor is to present his programme, three levels of detail are defined. At the first level, a programme using large general activities is to be produced, but this is to be supplemented with more detail later. This is to be provided at least four weeks before the commencement of any item of work. A further level of detail is also recognized as possibly being required. In effect, this clause not only allows but positively requires the contractor to amend the contract programme continually.

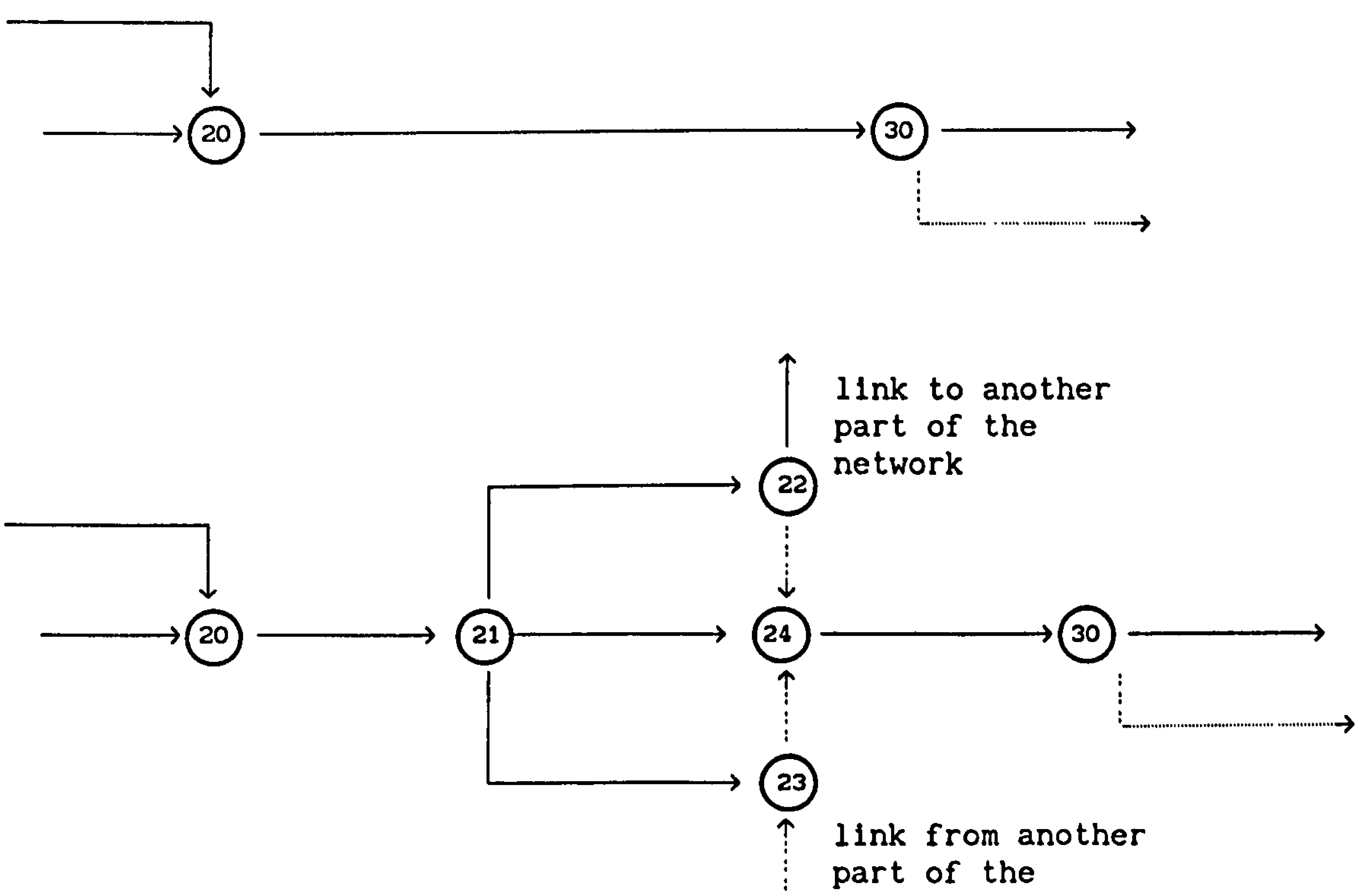
In contrast to this view, Driscoll (33) recommends obtaining an agreed schedule as soon as possible, and shuns the recommendation that a preliminary schedule should be requested followed by a more detailed schedule. He bases this view on the need to have a clear understanding of how the contractor intends to carry out the works. It has been recognized by certain writers that although some of the restraints in a programme are inescapable, there will typically be an element of what has been called 'preferential logic'. That is, opportunities for the contractor to impose his own preferred ordering of activities on the plan. Driscoll estimates that for a building, as much as 40 - 50% of the network logic could be preferential rather than absolute. If the engineer is to assess the contractor's claim for delay, it is argued that the contractor's intended order of construction must be ascertained to provide a starting point. It is for this reason that he recommends getting a contractually agreed schedule as soon as possible.

The two principal areas for discussion in this sub-section are thus closely connected. The argument about what level of detail should be used will be affected by whether it is seen to be acceptable to augment the original contract programme by providing more detail at a later stage. If this can be done while retaining a good, clear understanding of the contractor's intended method of procedure, then the acceptability of this practice should not be in question. This would require that whenever additional detail was provided by the contractor, the effect on the original programme should be made clear. The problems that might arise are illustrated in figure 6.4. In this figure, a broad activity 'construct bridge' has been replaced by the constituent smaller activities, but the links to the main network have not been changed. Such amendments are quite simple to incorporate. In figure 6.4(b), the replacement activities have involved additional links into the main network that will clearly have a greater effect on the programme as a whole. However, providing the expansion of detail is demonstrated, not just in bar chart form, but also in network form, the actual programme will still be intact. So that the original event numbers of the contract programme do not have to be amended, it would thus be wise to insist that all original event numbers are multiples of ten. This will allow the extra events that are created by the added detail to be slotted in (activity-on arrow format).

Although an argument has just been put forward to permit the provision of additional detail to the contract programme, it is not considered that this should be required (as NG 1/13). Changes to that programme are likely to be confusing enough without actually ordering them. The possibility that new detail recently added to the original programme may have to be amended by subsequent provision of detail is likely to exacerbate the problems of keeping track of exactly what constitutes the current programme. Where additional detail is required by the



a) Activities added without amending the main network logic



b) Activities added and logic amended

Figure 6.4 Adding activities to an existing programme engineer, then the contractor should provide it together with its impact on the network logic. Otherwise, it is considered that an attempt should be made to get sufficient detail in the first instance.

Some uncertainty was evident amongst the survey respondents regarding the programming of provisional items. Should activities be included in the programme to cover such work? Abrahamson (2) says that no extension of time should result from a contractor carrying out work against a provisional item up to the value in the bill. This should hold unless the nature and extent of the work involved are unclear or later changed. It would seem sensible, even with such an eminent view being clearly expressed, to remove any doubt. This could be done by including a statement that provisional items should be programmed to the extent that their work content can be recognized.

The main recommendations for section A: The Format of the Contract Programme will now be listed.

a) Except for the smallest and simplest of contracts, contractors should be required to use CPM to plan projects.
b) The project plan should be presented to the engineer in the form that best suits the contractor. However, there should also be a full listing of the network so that the logic and scheduled dates can be clearly

reported. In cases of discrepancy, it should be the listing that takes precedence.

c) Soft links between activities should be represented as normal dependencies in the project plan.

d) The work of the project should be broken down into activities that represent recognizable parcels of work, distinguishing between different geographical locations and different types of work. Where the duration of an activity is greater than two months, some measure of output should be given at monthly intervals.

e) Where additional detail is requested by the engineer, the contractor should identify, not only the new activities and their scheduled dates, but also the way in which the original logic has been affected by this amendment. This should also hold true for instances where the original network logic has been changed for whatever reason, and a revision to the network is necessary.

f) Event numbers used in the original network should be in multiples of ten to allow for additional sub-networks to be added.

g) Broad general activities that are used to avoid showing the minutiae of network logic should only be used where the overall duration is 1 month or less. They should always indicate the constituent activities from which they are composed.

h) A statement should be included to indicate that provisional items are to be programmed to the extent that their work content can be recognized.

There are two other matters that need to be considered here, but that are not strictly included under the section title. These are, the provision of information on resources and details of the contractor's earthworks intentions. On the first of these points, it seems highly sensible that details of the contractor's main productive items of plant should always be requested. Only with such information can the engineer hope to check activity durations. On the second point, it is also recommended that the contractor should be required to provide an indication of his intended earthworks operations. If the engineer has provided a summary of the volumes of excavation and compaction in the main areas of cut and fill, with an indication of volumes of import/surplus and the expected classification of the excavated material, then the contractor need only indicate what fill he intends to provide from what cut/import. An attempt to understand the contractor's earthworks plan from the contract programme on the site visited convinced the author that this additional information is essential. This view was confirmed by responses from Contractors in the survey concerning how they normally programme earthworks. A variety of alternative methods was revealed.

B Checking the contract programme

The standard documents in both U.K. and U.S. construction either anticipate or spell out that the contract programme will be checked by the supervising engineer. Nevertheless, the literature in both countries contains surprisingly little advice on how this should be done. In some of the U.S. documents, the timing and involvement of personnel in this check is fully described. The identification of certain general aspects of the procedure, however, is not the same as recommending how the check should be carried out. It is this essential advice that is in short supply. Of course, the U.S. tendency to define the form of the programme in considerable detail may suggest that the plan supplied need only be assessed against these stringent requirements. If everything has been specified then perhaps the majority of the check can be accomplished by ensuring that the programme presented lives up to the specification. But is it really possible or sensible to specify to such a level that little uncertainty remains? What is to be done when the programme fails to comply with the specification? Whatever the answers to these questions, it is certain that the U.K. situation is quite different. Here, many engineers make no effort to detail how the contractor should provide this programme at all and those who do specify are unlikely to do so in great detail.

What importance should we give to this checking process?

It was clear from the survey that most engineers interviewed considered the check to be very important; but why should this be? Some of the reasons may be manifest, nevertheless, an attempt will be made to record those that can be identified. They are:

i) to ensure that the contractor has fully understood the requirements of the contract;

ii) given that there may be choice in how to execute the works, to make certain that the contractor has adopted a sensible ordering and arrangement of activities.

iii) It is recognized that to control a project, there needs to be a plan against which actual progress may be compared. Only if this plan is a reasonable attempt to predict achievable progress can this comparison have any value.

iv) The effects of delays on a project assessed part-way through the scheme will require a good appreciation of the pattern of work to be completed following the delaying incident. This will mean that the plan as a whole should be as good a representation of likely progress as possible.

If the importance of this check is accepted, then it will be recognized that to carry out the check properly will probably take several hours of intensive study. How is this to be achieved on a busy construction site? Near the beginning of a contract, the resident engineer's offices are likely to be particularly hectic, with senior staff being regularly interrupted by internal and external calls on their time. Yet it is the resident engineer and his senior staff who must have a sound understanding of this programme if they are to make good use of it. How better to understand the programme than to study it carefully and find out its failings? The author was aware of these problems on the sites studied and felt at the time that it would be wise if a senior member of the R.E.'s staff were to leave site for 1-2 days while the check was carried out. If design office staff with a good knowledge of the contract could be available to assist, this would also be helpful.

In the survey, a question was asked concerning the extent to which engineers would question the contract programme. Were they only looking for a reasonable overall picture or would they want to query even the smallest of discrepancies? Most respondents fell into this second category and would expect clarification of any of their uncertainties concerning the programme. Such an approach is supported by Wallace (3), who confirms that engineers should not hesitate to document any doubts re the feasibility of the programme submitted. It may be that all that is needed is clarification, but to obtain an unambiguous appreciation of the programme, the questions must be asked. There now follows a check-list that is intended to help the R.E. to carry out an organized assessment of the contract programme that stems from the interviews, discussions and thoughts generated from this research. It will be clear that the approach suggested involves a number of scans of the whole programme, each time checking a different aspect. For the purposes of completeness, nothing is assumed to have been specified concerning the format of the programme other than what is contained in clause 14 of ICE5.

i) Check to ensure that all aspects of the programme can be understood. This will include activity descriptions, scheduled dates, any links that are shown (mysterious dotted lines(?)) and any notes to the programme as a whole. It should be clear what work is included in any all-embracing activities, such as 'finishings'.

ii) Check that all constraints on the contractor's activities have been properly incorporated, viz.:

a) time for completion and any sectional times for completion;
b) pre-arranged suspensions of work;
c) allowance for other contractors (especially public utilities) to the extent that their requirements are made known;
d) compliance with any arranged possessions (waterways, BR, etc.);

e) compliance with any enforced delays notified in specification clauses, e.g., stripping formwork from soffits, overlaying pavement layers, loading roof slabs/bridge decks;

f) ensuring that all road and pedestrian accesses that are to be maintained have been considered;

g) ensuring continuity of supply in all public utility services, where this is required;

h) any other imposed constraint.

iii) Check that all relevant work has been included in the plan, viz.:

a) main contract work, with all aspects fully represented;

b) either indicate or make provision for the work of other contractors and public utilities;

c) where activities have been included that refer to work to be carried out by the engineer, these should be scrutinized.

iv) Check activity durations, in particular those of the major activities and indicate where these seem unreasonable. It is assumed that the contractor's major resources will be known. The following should be noted in carrying out this exercise:

a) the contractor is likely to have a better understanding of the productivity of his plant, and providing he makes an honest attempt, should be better able to assess durations than the R.E.;

b) assessing the output of a set of resources is an inexact science that will be affected by several factors, including weather, ground conditions and conditions of access;
c) activity durations may need to incorporate such elements as: time for concrete to harden/attain strength, stripping formwork, intermittent working where necessary;
d) the duration of an activity need only relate to substantial completion of the element of work: to the level that would be acceptable for granting a certificate of completion.

v) Check the plan's logic, which should include as a minimum, a feasible and sensible ordering of the activities in the job. Ensure that:

a) the reason for all dependencies is understood as required by either hard or soft logic;
b) all soft links are properly incorporated as links;
c) sensible overlaps between activities have been adopted, where used;
d) activities that will use the same limited resources do not occur simultaneously;

e) haul road restrictions on access have been recognized - some parts of the work may not be able to be constructed until new lengths of road are built, thus providing the necessary access.

Not all activities are easy to represent on a project plan, and this should be borne in mind when carrying out the check. In the survey, contractors admitted their difficulties in trying to schedule such activities as services and the works of their subcontractors. Another difficulty experienced by contractors, although of a different nature, was in getting approval of their programme. A procedure, adopted by some American contractors of including in their programme submittal letter that approval would be assumed unless some response was received within 30 days, seems a reasonable way of overcoming this problem.

C Validation of delay claims

As we have seen in chapters 1 and 2, there is a considerable difference between the U.K. and U.S. approaches to this problem. Exactly why this might be will be addressed later, but for the moment it is only necessary to be reminded of this contrast. It is true that in both countries methods are suggested that compare the contractor's actual progress with his planned progress in a very general way. The difference between these two is then examined to identify the effects of delays. Graphical approaches including the use of S-curves fall into this category and although a practical solution, they do not stand up to any serious analysis. Outside these methods, the U.K. literature may recommend the use of CPM to solve these matters, but typically does little more than this. Only Hughes (6), in commenting on concurrent delays appears to see more of the difficulties and yet he only considers a small element of a network. The results from the questionnaire survey did nothing to suggest that any further development had taken place beyond what is recorded in the literature except for the concept of 'entitlement'. This will be dealt with later.

The progress that has been made in this field in the U.S.A. is represented by the use of Adjusted CPM Schedules and the technique called Time Impact Analysis. The first of these recognizes the need to construct an as-built record of actual progress and delays, not only for what is conceived to be the critical path, but for the whole of the network. Having achieved this, an adjusted CPM is produced in an attempt to predict how the contractor would have progressed if unhindered by type E delays. It is suggested that this represents a considerable step forward in the identification of a valid mechanism for dealing with these disputes; the only question seems to be whether this approach is always practicable. Some problems still exist with this method in how to deal with certain types of concurrent delays, as pointed out in chapter 3. The essential logic, however, appears particularly persuasive. Time Impact Analysis may be seen as employing this same logic, but doing so progressively as construction proceeds and delays occur.

During the course of this research, a greater appreciation of some of the problems associated with these matters has developed. These will now be discussed, followed by what is believed to be good practical advice on how to deal with delay claims.

i) Identifying the critical path

In all the literature surveyed for this thesis, the expectation is that a critical path for the completed project will be readily identified. This was also the view of the majority of Engineers and Contractors interviewed. Some did admit that it was not always easy and some, by their comments, showed that they had an odd appreciation of what constituted a critical path in practice. There will surely be contracts on which one major path through the CPM network is by far the longest and most complicated. This will almost certainly start and finish the contract as the critical path for the project. However, on contracts where secondary paths have similar lengths to the initial critical path, the position may not be so clear. The concept of the critical path is most easily understood from a CPM network prepared at the planning stage. Here, all activities will continue to completion when started and the critical path or paths may be identified as having no float when minimum project time is enforced. This idealized state is unlikely to exist on a real project, where activities will not always start as soon as they are able, and may also be worked on intermittently. Identifying the critical path in such circumstances, even when the progress records are complete, will require a greater understanding.

On examining the subnetwork in figure 6.5(a), which represents records of a completed project, activity B appears to have some float when compared with activity A. In adjusting this network, this means that on removal of type E delays from the sub-path including A, the network could be compressed by an amount X. This might lead to an extension of time with costs for a duration of X. However, when we examine fig. 6.5(b), a different result is obtained. Here, activity G was not started until Y days after event m was achieved. If this was not caused by delays due to the Employer, how are we then to adjust the subnetwork? It is suggested that in this case time Y cannot be seen as float, but must be considered as a type C delay. With this interpretation, no compression of the network and thus no right to any extension of time could result.

Figure 6.5(c) shows another diagram of a completed network

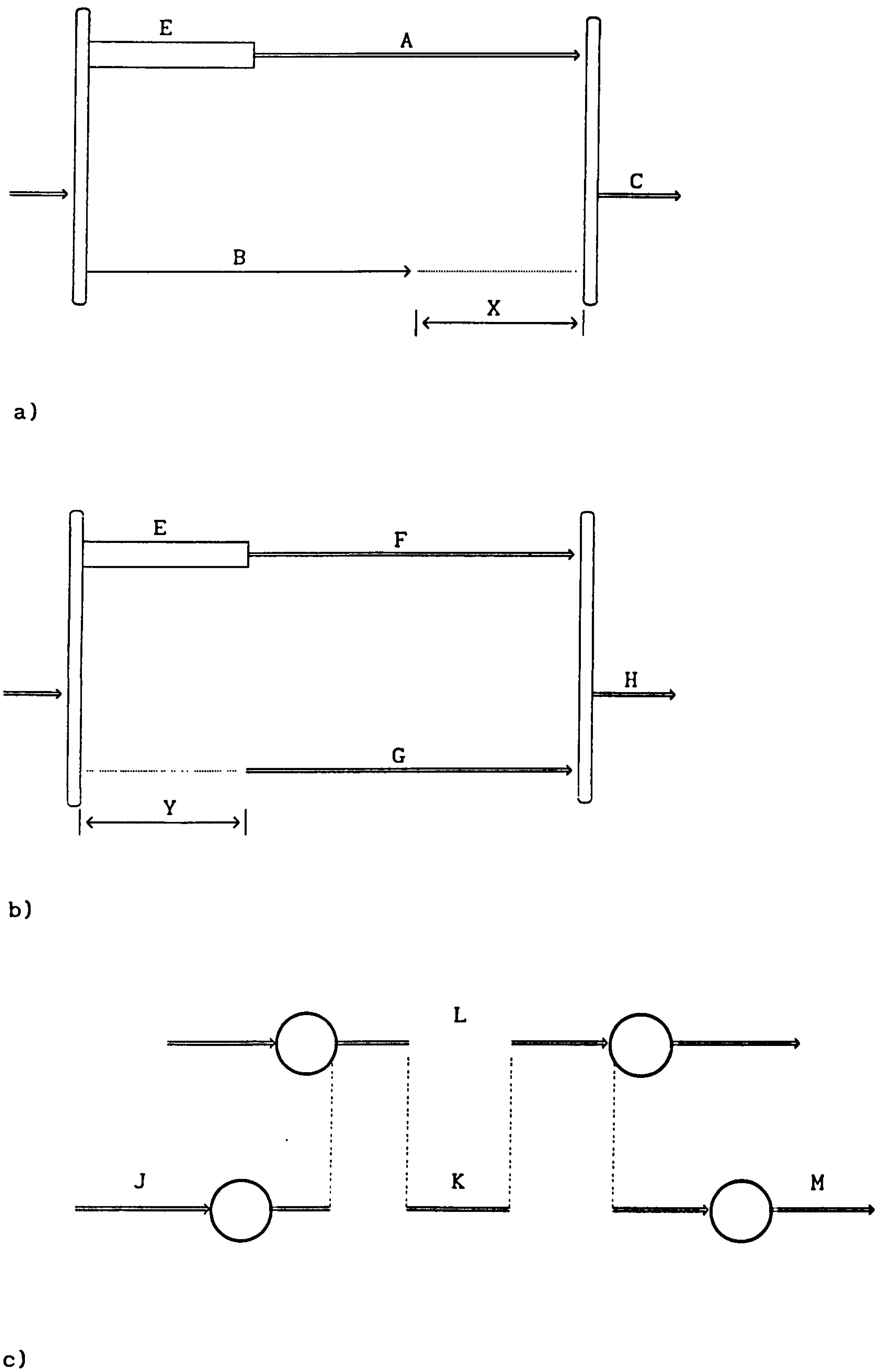


Figure 6.5 Identifying the critical path in practice

that might well be confusing. Some activities do need to proceed intermittently, while others may do so because resources are being swapped between activities demanding those same resources. This situation is shown in the diagram and may be effectively covering up a more detailed network (dummy activities), that is not shown in the clause 14 programme. When recording the progress of the works, the R.E. would be well advised to query the contractor's failure to start important activities or to carry out work intermittently to identify the cause. In the situation shown in fig. 6.5(b), it should help him to confirm that the delay was not attributable to the Employer.

The main aim of this section is to make the point that the critical path may not always be easy to distinguish on a completed project. The normal method of identifying this path on a planning network may have to be rethought to allow for the anomalies highlighted. The possibility that parallel critical paths might be found has already been discussed in chapter 3. Because activity durations in real life will be measured in real numbers not integers, it seems that this concept may be incapable of being realized.

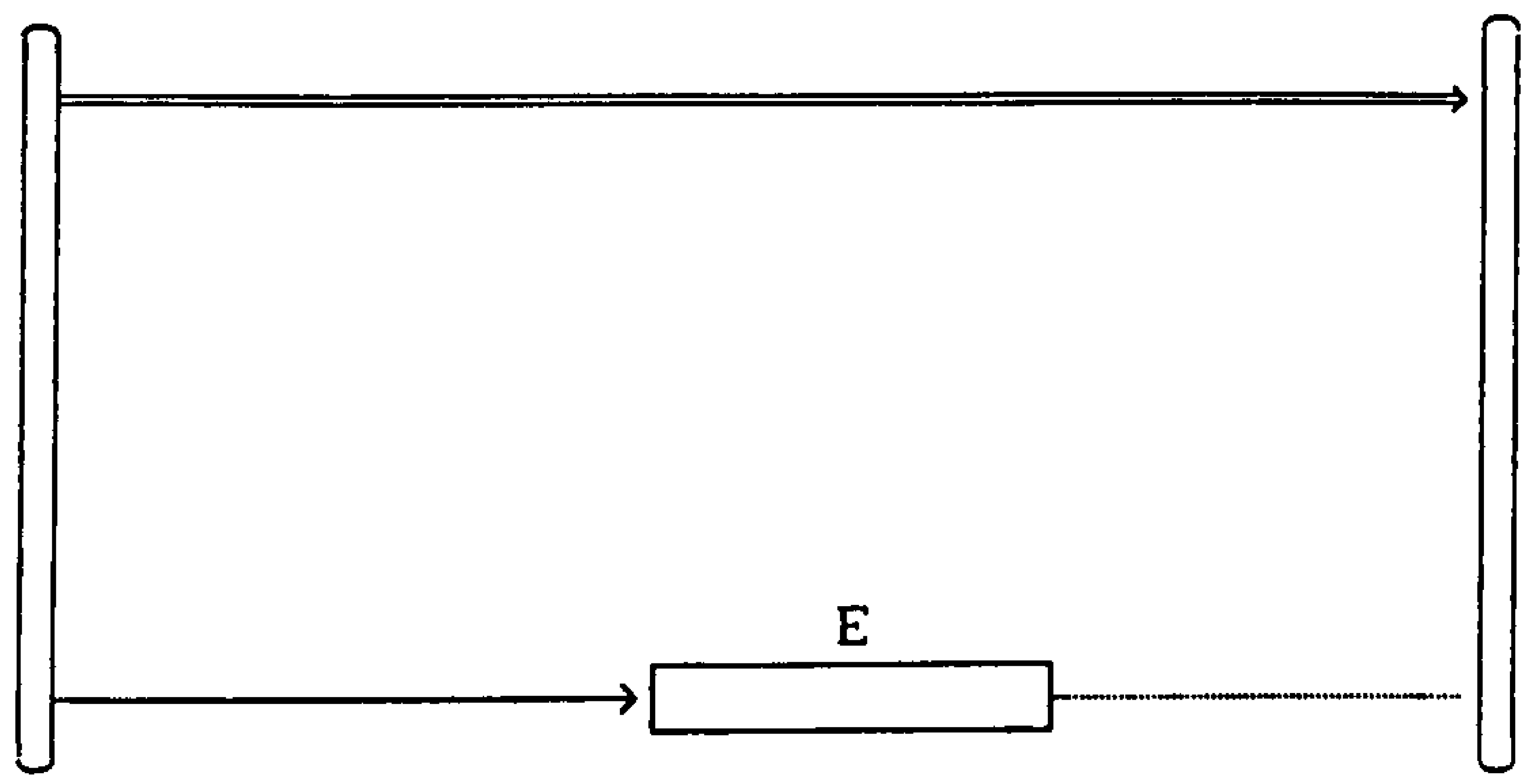
ii) The ownership of float

A number of writers, when discussing the problems of dealing with delay claims, also address the problem of 'who owns the float?' The alternatives that are considered are either that the employer or the contractor or neither party owns the float; this last option being sometimes seen as the project owning the float. Galloway and Nielsen (37) support this third view, which leads to a statement that,'extensions of time for performance will be granted only to the extent that equitable time adjustments for the critical activities affected exceed the total float or slack along the paths involved.' Fondahl (19) concurs and confirms that judicial decisions are in line with this view; when a type E delay has only consumed float time, the contractor is not entitled to an extension of time. Sweet (28) analyses the problem in a little more detail and considers a case in which an activity with 30 days float is affected by a 20 day delay type E and a 20 day delay type C. If float belongs to the contractor, he argues that the employer would be responsible for the contractor's delay expenses. If float is shared between the parties, two possible judgements are considered. One depends on which of these two delays occurs first. If the type E delay occurs first, it is argued that it must have been the contractor's delay, occurring second, that was effective in delaying the whole project and he should suffer. The outcome would thus depend on the order in which the delays occur. The alternative judgement says that each party is equally at fault and should share the time-related costs.

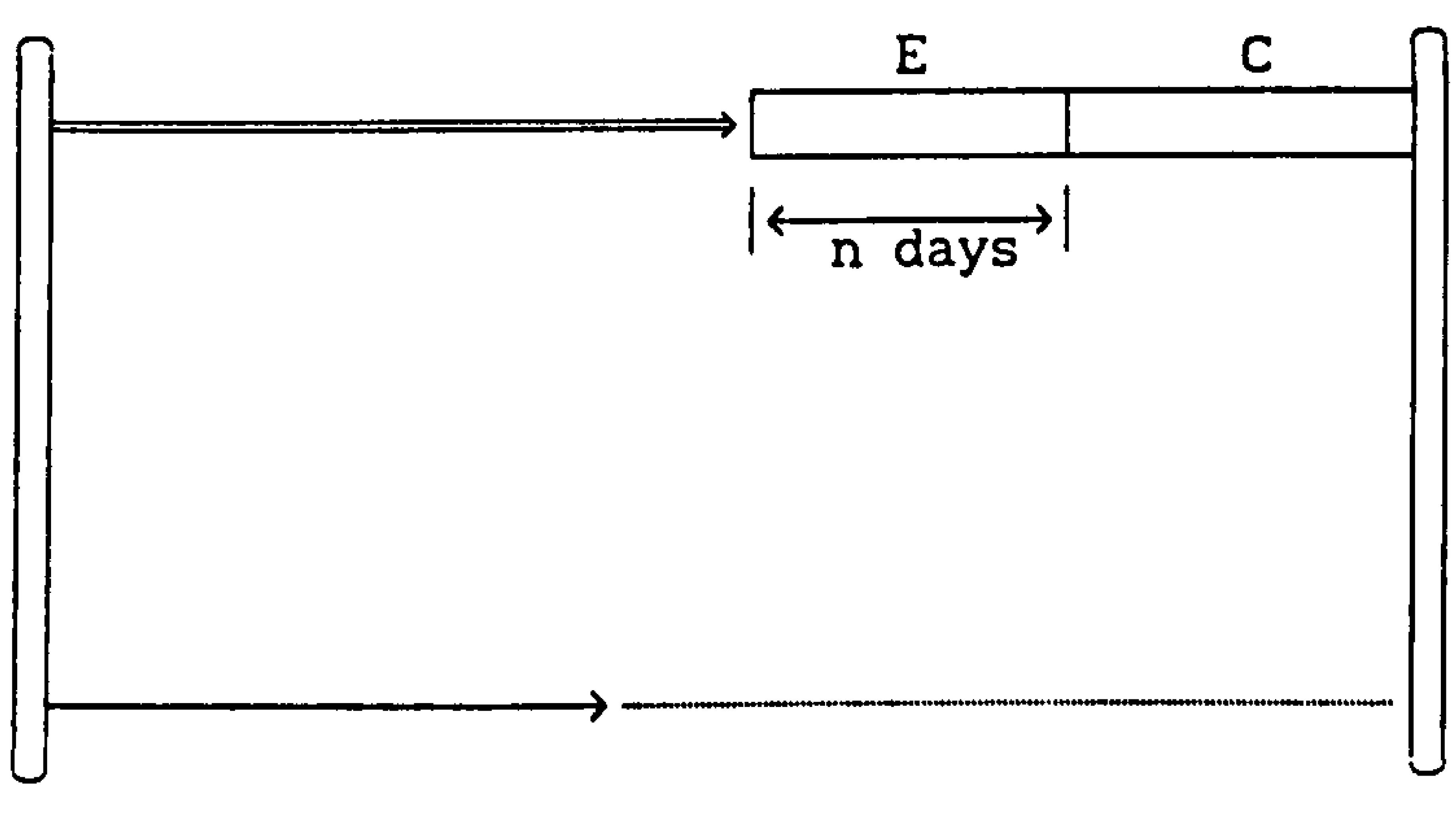
None of these writers consider the 'adjusted CPM' method of dealing with delay claims when discussing ownership of float, and yet the two are surely closely related. If we consider float as the actual float that did exist at the time the activities took place, and not the float predicted to be available at the planning stage, then the adjustment of networks that takes place to determine the contractor's rights effectively dictates float ownership. In figure 6.6(a), the adjusted network would not give the contractor any right to an extension of time, because in the absence of type E delays, the contractor still could not complete any faster. This concurs with the view stated by Fondahl that when the type E delay only consumes float, the contractor is not entitled to an extension of time. In figure 6.6(b), the adjusted CPM that allows us to recognize the time in which the contractor could have completed the job in the absence of type E delays, would give an extension of time with costs for n days. This would be true, irrespective of which delay came first. The issue of float ownership is thus effectively overridden if we accept that networks should be adjusted in this way.

iii) Entitlement

During interviews with some of the Contractors, a method of endeavouring to convince the engineers of the validity of their delay claims that they considered to be demonstrating their 'entitlement' was outlined. The initial reaction was that this was an attempt to construct an as-built network similar to those described by Antill (34) and Wickwire &



a)



b)

Figure 6.6 The ownership of float

Smith (25), but this was soon found not to be the case. The network that these contractors were constructing did not incorporate actual activity durations, but simply entered all type E delays into the original clause 14 contract programme. In doing this they hoped to show that the actual time it had taken them to complete the work was less than the time generated by this process, and to which they considered themselves entitled. They would then argue that this proved they had been particularly expeditious in carrying out the work and hope that the engineer would pay their full costs.

It is easy to see how such an approach might be attractive to contractors. The method involves a process which it is easy for them to carry out and that avoids any dispute about concurrent delay situations. If the contractor uses activity durations in the contract programme that are generous, he can be sure that the entitlement programme will show that he has been particularly efficient in carrying out the works. It is also true to say that the final critical path through the constructed network might involve no type E delays and therefore no right to any delay expenses. However, this would not show up in the submission made. In some circumstances, this procedure may properly highlight the real state of affairs, but it is considered that this certainly will not always be so.

iv) Concurrent delays

Some of the difficulties of dealing with concurrent delays were discussed in chapter 3. There it was strongly suggested that providing an 'adjusted CPM' approach to dealing with delays was adopted, concurrent delays on parallel paths would not cause problems. Indeed, the likelihood of finding parallel critical paths in practice was considered most improbable. That still leaves unresolved the case where two or more concurrent delays both affect a single activity (figure 3.6(a), chapter 3). This problem must be overcome, for without a solution, no as-built CPM that incorporates such a situation can be properly adjusted to determine the contractor's rights. Quite how this should be handled, however, remains in doubt. There certainly seems to be no legal precedent in the U.K. as appears to exist in the U.S.A. and thus no common agreement on how such matters should be reconciled is universally accepted. In the absence of such an edict, one option open to the engineer is to specify in the contract documents the rulings that are to be adopted. It is suggested that such rulings would be more acceptable if they had been proved to represent the majority views of the profession: something that could be achieved by more detailed questionnaire surveys, similar to the one carried out for this thesis. Such an approach would surely be helpful, but following the discussions in chapter 3, it may be that some apparent concurrent delay cases need not be resolved in this manner. Where one delay is 'unaffiliated', i.e., not essentially fixed to occur at a particular time, then it may be possible to consider a situation in which the delays need not be seen as concurrent. It may be possible to deal with the problem as a series of delays to the activity in question. The main point to be made then, is that any rulings should not be applied blindly. Where common sense dictates an outcome different to that which stems from applying the ruling, then the common sense ruling should prevail. A similar attitude can be recognized in the literature on 'adjusted CPM' networks. There is no suggestion there that the mechanism can be so well defined as to allow computers to adjust the as-built networks. Always, there will be a need for judgement, guided by sensible principles and rulings where these cannot be avoided.

v) Dealing with delay claims

Through the period of research contributing to this thesis, the different positions of the engineer and the contractor in dealing with delay claims have been repeatedly recognized. The contractor's main concern in all these matters must clearly be to make every effort to recover the costs that he considers are due to him, and to avoid any payment of liquidated damages. His concerns are likely to be less that a just solution is obtained than that an award that is beneficial to his company is made. This is a very proper position for the contractor to hold. Provided he does not attempt to obtain such an award fraudulently, he should argue the facts, as they are known, to his benefit. The engineer, on the other hand, must adopt a quite different stance. He must aim to make a settlement of the contractor's claim that is just and equitable. In this he needs to know the facts, and preferably to adopt some method of analysis of these facts that will produce a fair outcome given the rules and conditions adopted for the contract. From what has been written already, it is considered that the method of analysis most likely to produce this outcome is one that attempts to adjust the as-built network, as described by Wickwire & Smith (25). It must also recognize the problems of concurrent delays. In ICE5, the engineer will have to deal with delay claims, not just at the end of the contract when the project is complete, but also part-way through the project. This means that he must be able to predict the results of delays at any time during the contract period and this requirement is best met by a system that is ongoing. Both the Adjusted CPM approach and the Time Impact Analysis method can be used in this way, but it is felt that the basic technique benefits from a slightly different interpretation. This revised description of what is essentially the same basic system will now be explained.

As each event in the network is achieved on the contract in question, the engineer should:

a) identify all delays and actual activity durations on all paths that lead to that event;

b) attempt to identify not only the duration of delays, but also the party responsible;

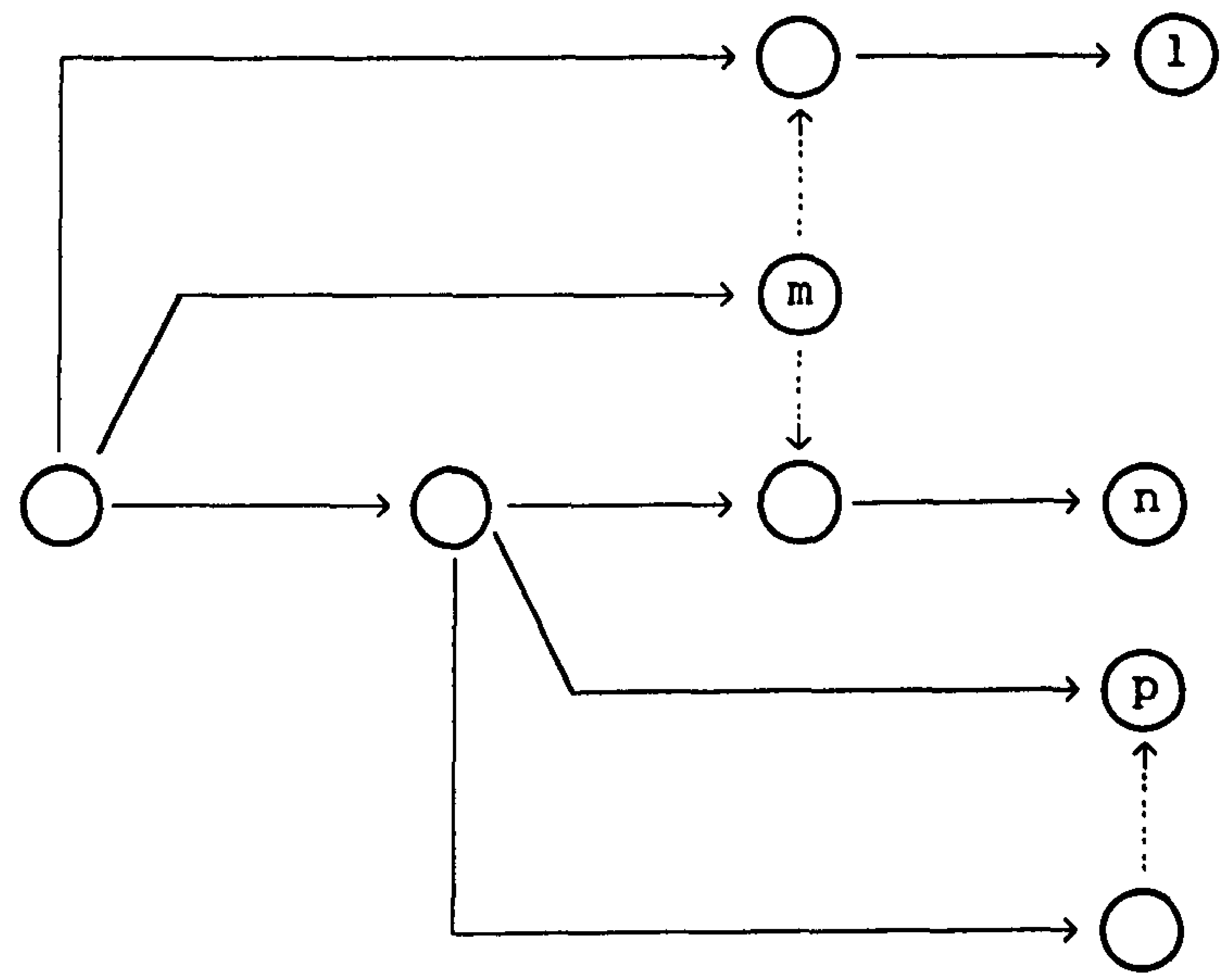
c) recognize concurrent delay situations and, taking all the facts into account, reduce these to single delay effects;

d) with full knowledge of the relevant facts, assess the time in which the contractor could have achieved this event in the absence of type E delays.

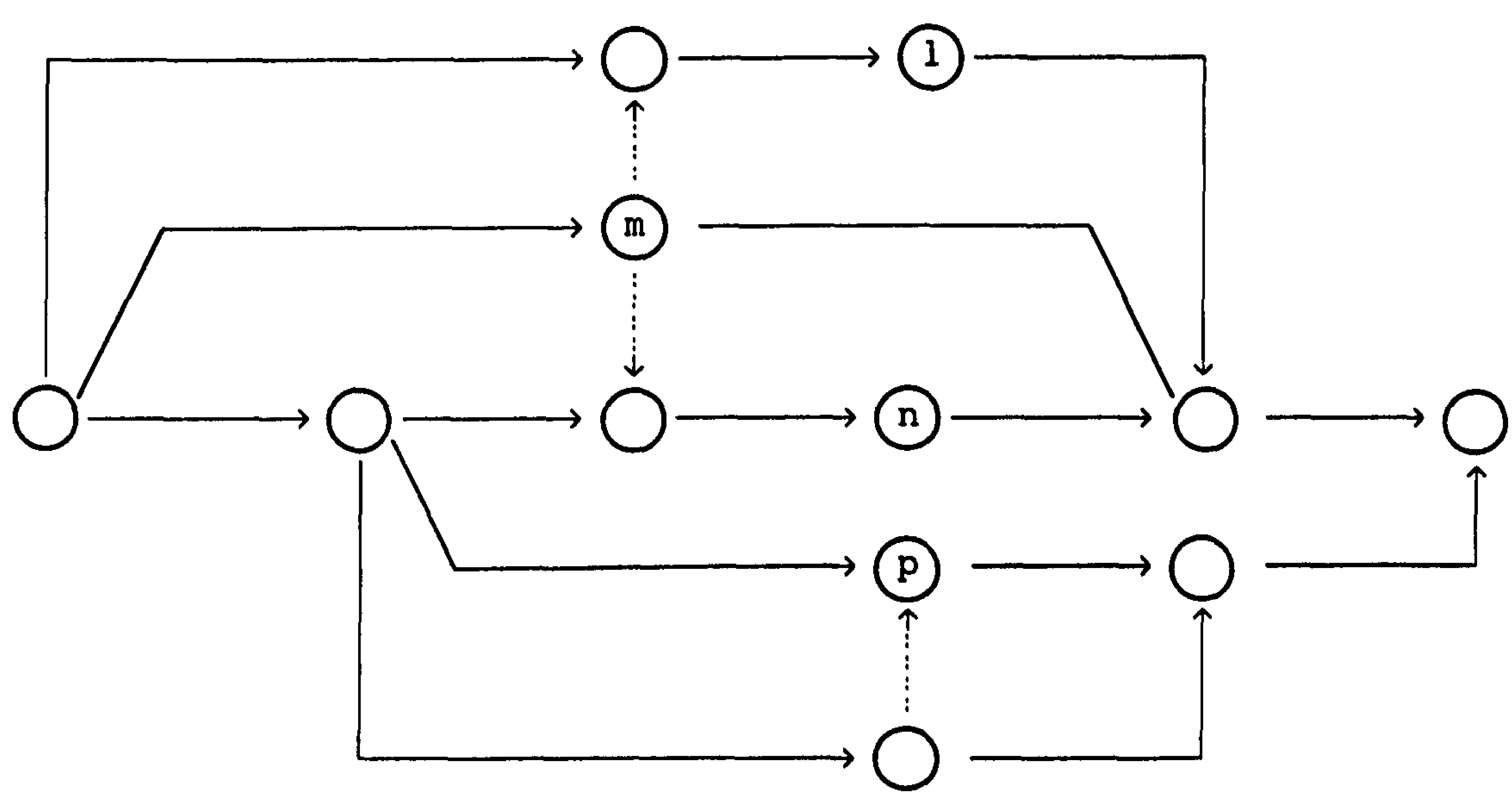
This approach, which does not attempt to identify a critical path, will eventually do so when the event being considered is the one that represents completion of the project as a whole. Looking at figure 6.7(a), as each of the events l, m, n and p are achieved the logic that is being suggested would be argued as follows:

> 'We do not know whether event l will be on the path that eventually dictates the final outcome to the project, but if it is then the time to l is X and the time that the contractor would have taken to get to l in the absence of type E delays would be Y. We do not know whether event m will be.........'

This is exactly the kind of argument that is adopted in the 'travelling salesman' problem which is typically used to introduce the concepts of dynamic programming. There



a) Progress assessed at each event on each path through the network



b) Completion of the project

Figure 6.7 Continuous assessment of network paths should be no surprise in this, although it has not been recorded anywhere else in this context, to the author's knowledge. One definition of the principle of optimality, upon which dynamic programming depends is: the overall shortest route from origin to destination contains the shortest route from origin to any intermediate destinations on that route. This will work equally well to find the longest route and that is effectively what the critical path is. By proceeding in this way, it is then possible to progress through the network building up optimal information about each major path. When these eventually join (fig 6.7(b)), valid information about the project as a whole will have been determined. Of course, to predict the outcome of the project part-way through, it is necessary to fit the planned activities beyond the current position, modified if required, to the actual as-built section of the network.

The main advantage of this approach is that decisions concerning liability are made when the facts are fresh in the mind, contemporaneously as the project progresses. It is admitted that for some delays there will be debate concerning which party is responsible, but it is felt that this would simply result in two alternative decisions being recorded. The choice from these two could be made later when liability is finally decided. For many events there will be no analysis to be performed. If no delays have affected progress on a path since the last event, then no change in the assessment will be needed. The problem of dealing with weather delays may well have to be left until the project is complete, when the project weather may be compared to expected weather for the region. It may be possible to make an interim assessment, but as was seen in the survey, contractors tend not to want to claim for extensions of time without costs. They would rather pin any extension down to delays for which the employer is responsible in the hope that costs would also be payable. The onus then, may be on the engineer to ensure that the effects of weather are properly taken into account.

D Recommendations for future work

A part of this thesis, in particular chapter 3, has considered the way in which contractual claims may be modelled to determine liability. In that chapter, ideas concerning the nature of delays were put forward in an attempt to improve the realism of these models. To make yet more improvements, it is considered that more needs to be known about the types of delay which occur and a greater understanding of their effects on the progress of the works. This could only be done by detailed study of real delays as they affect real contracts. There thus needs to be an unbiased study of project progress over a long enough period to identify all knock-on effects of such delays. This would clearly have to be repeated on a number of contracts.

In chapter 5, a number of 'concurrent' delay situations were presented to Engineers and Contractors to identify their attitudes concerning how they would treat such combinations in a claims situation. This was felt to be an interesting and useful method of discerning how these professionals viewed such matters and could certainly be pursued. There are clearly a number of other cases which were not tested and on which a common view might provide the basis for specification clauses to lay down how these matters should be treated. Greater realism from the results of an improved knowledge of the nature of delays would certainly assist this process.

Some doubt has been cast on the ease with which the critical path on a real contract can be identified. This is of particular significance to all methods of assessing delay claims. Again, the best way to learn more about this area would be to be closely associated with a number of contracts and to record progress on a daily basis to try to identify this most important succession of activities. Such a procedure would be ideally carried out using the record-keeping program described in the next section of this thesis.

Finally, a lot of the questions addressed to the interviewees and discussed in chapter 5 relate to the way in which these people already deal with delay claims. No standard approach was readily identified. If access could be gained to a number of contractor's claims submissions, together with a resumé of the engineer's decisions on these claims, a greater insight into this process would be obtained.

With all of the areas suggested for future work, there is the basic problem of needing to be closely associated with contracts and of doing work on those contracts which relates to sensitive matters. It is recognized that gaining permission to do such work may prove difficult, and that it will take a long time to gain data on a small number of contracts. Nevertheless, if advances are to be made in this area, then this would seem to be the best way forward.

CONCLUSIONS

The findings from the questionnaire survey are detailed and summarized in the various sections of chapter 5. It is intended, therefore, that this part of the thesis should simply report the main points discussed there, and allow the reader to gain more detailed information from that source. The main findings will now be listed.

i) There was no consensus amongst Engineers concerning whether to specify the format to be adopted for the contract programme. Some Engineers were content to rely on Clause 14 of ICE5, while others used a specification clause to identify the required approach.

ii) Left to their own devices, Contractors preferred to use a format for the contract programme that did not reveal the logic of the project. Such diagrams as bar charts and time/distance diagrams were most popular. However, most Contractors did use CPM to plan their projects.

iii) Engineers carrying out checks on contract programmes were most concerned that activity durations were sensible, that the logic of the plan was sound and that it complied with any specific restrictions detailed in the contract.

iv) The principal failing of most contract programmes concerned lack of detail, and some programmes were said to be not very professionally produced.

v) The most important use made by engineers of the contract programme during construction was as a control tool.

vi) Only the top staff in both Engineer's and Contractor's site organizations were deemed to have a good knowledge of the programme.

vii) Extension of time claims occur on 60 - 70% of civil engineering contracts.

viii) Liquidated damages are sometimes deducted by the Employer, but this happens only rarely.

ix) Both Engineers and Contractors strongly supported the view that a claim for extended overhead costs might succeed even when the time for completion of the contract has not been exceeded.

x) There is a strong desire to award an extension of time for a delay that it is accepted will affect the completion of the project as a whole: even when it seems clear that no extension of time to defray liquidated damages will be needed.

xi) In the concurrent delay situation, where delays type E and C simultaneously delay a single activity, the majority view was that this should be treated as a delay that would merit an extension of time but without recovery of overhead costs.

xii) There is some evidence to suggest that U.K. engineers and contractors will assess/make an extension of time claim simply on the basis of the delays on an identified critical path. This is contrary to the U.S. approach of looking at the whole as-built network for the contract.

As previously stated, the second topic to be addressed concerns the different approaches that are adopted in the

U.S.A. and the U.K. to the problem of delay claims. The last of the findings just recorded expresses this particular anomaly quite well. U.K. professionals, as witnessed by the results of the survey and the literature review appear to consider only one identified path through the completed network when assessing extension of time claims: the critical path. This may lead to an invalid award resulting from not taking account of other network paths. The systematic approach described by Wickwire & Smith and loosely titled Adjusted CPM Schedules is considered to represent a valuable advance in this field. The question is why has this advance been made in the U.S.A. and not in the U.K.?

No investigations have been conducted in an attempt to answer this question and so any solution offered must be seen simply as supposition. There are, however, factors that may account for this discrepancy. It appears from the literature that adoption of CPM for construction projects in the U.S. has been more widespread and more whole-hearted than it has in the U.K. The existence of very complicated specification clauses to require its use as discussed in chapter 2 is evidence of this. However, to point to this as the reason for the difference does little to resolve the argument. Why, it might be asked, has CPM been more widely adopted in the U.S.A.? A more fundamental reason is needed and it is considered that this may be found in the differing methods of dispute resolution to be found in the two countries. In the U.K., any dispute that cannot be resolved between the two parties in a civil engineering contract must be settled in an arbitration hearing. This procedure is, of course, a private arrangement and thus the only parties to become aware of the outcome are the ones involved. In the U.S.A., most substantial claims will be heard either in the Government Board of Contract Appeals or in open court. Both procedures produce decisions that can be cited as legal precedent, and it is believed that this may be the reason for the advanced state of understanding of these matters in the U.S.A. When precedent is set in this way, the law can develop and recognized mechanisms for dealing with these problems can be identified. Having made these statements, it should not be assumed that the author necessarily believes that dispute resolution in the U.S.A. is any more efficient or cost-effective than in the U.K.. These matters have not been addressed.

This would have been the end of the first section of the thesis in normal circumstances. However, in the light of two recent events, that are both important and relevant to the area of study, it was considered essential that some comment should be made here. The two events are the publication of the 6th edition of the I.C.E. Conditions of Contract (45) and the publication of the New Engineering Contract (46). As the interviewees questionned in this study were responding on the basis of contracts governed by ICE5, these new documents will not affect the validity of what has been written in this thesis. It does, however, seem sensible to identify any changes from standard ICE5 practice incorporated in either of these two documents that might have an impact on any recommendations and conclusions already made.

The approach will be to identify amendments to the way in which time is dealt with in both of these new documents when compared with ICE5. The impact of these amendments, as far as they can be foreseen, on procedures and methods will then be discussed.

The I.C.E. Conditions of Contract 6th edition (ICE6)

The principal amendments contained in ICE6 that affect this area are as follows:

i) A number of terms used in ICE5 have been amended in the revised edition. Thus, the 'Certificate of Completion' has become the 'Certificate of Substantial Completion' and the 'Period of Maintenance' will be known as the 'Defects Correction Period' (Clause 1).

ii) Where the contractor is required to design a part of the permanent works and his late submission of details to the engineer delays the engineer's further issuing of details to the contractor, this is to be taken into account by the engineer when considering any claims from the contractor for an extension of time (Clause 7).

iii) For a Clause 12 claim, the contractor can be required to report on the practicality, cost and timing of any alternative measures that may be available (Clause 12).

iv) A number of amendments have been made to Clause 14, concerning the contractor's provision of the programme. The programme is now said to show the 'order' rather than the 'order of procedure' in which he proposes to carry out the works. A more important amendment is that within 21 days of receipt of the programme, the engineer must now either accept it, reject it, or ask for more details. Failure to do any of these is to be assumed to indicate acceptance by the engineer. A time limit of 21 days has also been put on the contractor's provision of a revised programme where progress is found not to be in line with the existing programme (Clause 14).

v) The Works Commencement Date can be specified in one of three ways. It may be defined in the Appendix to the Form of Tender; be a date within 28 days of award of the contract notified by the engineer or be agreed between the two parties (Clause 41).

vi) On receipt of a claim for an extension of time, the engineer must initially assess the delay suffered and notify the contractor accordingly. Only then must the contractor's right to an extension of time based on this delay be considered. A time limit of 14 days has also been placed on the engineer's assessment of possible extension of time at both due date for completion (which may be an already extended date) and at the issue of the Certificate of Substantial Completion (Clause 44).

vii) A provision for accelerated completion has been included in the new form. Where this is requested by the engineer or the employer, the terms are to be agreed before any action is taken (Clause 46).

viii) Where no sum is recorded in the contract documents against the level of liquidated damages to be levied on default, no such damages are to be payable. Also, any variations issued after liquidated damages become payable that cause delay will suspend the employer's entitlement to deduct such damages for the part of the works affected until the delay ends (Clause 47).

ix) The I.C.E.'s Conciliation Procedure is incorporated as a means of settling disputes should either party wish to adopt this method (Clause 66).

The amendments made to the 5th edition to produce the 6th edition of the I.C.E. Conditions of Contract are considered by most commentators to be of a minor nature. This could certainly be said of the changes that have occurred in the specific area of this study. Nevertheless, those that have occurred will have some effect and will now be considered, with what are felt to be the most significant changes addressed first:

i) It was reported in the questionnaire survey that some engineers were particularly unwilling to approve the contractor's programme. Given the new wording in Clause 14, it seems that these engineers will no longer be able simply to ignore the problem. As pointed out above, failure to comment will in future be viewed as approval. The time limit placed on the contractor's provision of a revised programme should also tighten up procedures. It should ensure that the contract is not left for any extended period without a meaningful programme to identify expected progress. Both measures should make the issue of contract programmes more central.

ii) The way in which engineers are to respond to contractor's claims for extensions of time has been amended. The new wording recognizes a two stage procedure here. The first stage is to assess the impact of the delay in question, followed by consideration of whether this delay gives rise to a right to an extension of time. Separating these two issues in this way may be helpful in clarifying the issues and in allowing the two parties to more easily understand their differences. However, it still gives no assistance to the engineer concerning how this second stage of the procedure can sensibly be dealt with.

iii) The revision to Clause 46, where acceleration required by the engineer or employer is recognized for the first time seems highly sensible. It covers the case where completion is to take place before the time or extended time for completion and lays down that any special terms and conditions of payment should be agreed before any action is taken. In this way it should be possible to separate the impact of the agreed acceleration from any other delay claims submitted by the contractor. The problem of constructive acceleration is, of course, not dealt with by this new wording.

iv) The revision to Clause 7 now identifies the possibility of a delay for which the contractor is responsible being taken into account. This would undoubtedly figure as a type C delay that would have to be dealt with in any extension of time assessment.

The New Engineering Contract (NEC)

At the time of writing, the NEC is still a consultative document and as such subject to possible future revision. Nevertheless, it is this version, the only one currently available, that will be reviewed here. Differences between ICE5 and NEC concerning the time element of the contract are as follows:

i) Rather than specifying once and for all in the main text of the document, the NEC allows a number of aspects of the contract to be defined by the employer. The schedule of contract data (SCD) permits the employer to prescribe:

a) the period within which revised programmes are to be provided by the contractor;
b) the frequency of programme updates;
c) whether the employer is willing to take over the works early;
d) a period from the start of the contract to a stated time after completion: much like the maintenance period of ICE5.
e) starting dates and completion dates can be stated or may be the subject of negotiation;
f) weather parameters defining the worst weather to be expected in a return period of ten years;
g) whether the initial programme is to be submitted with the tender or not.

ii) Much more is said about the way in which the programme is to be submitted. It is to show:

a) starting, possession and completion dates;
b) the order and timing of activities listed in the works information, other activities the contractor plans to

carry out and the work of other people;

c) dates when the contractor will complete work needed to allow others to do their work, dates when the contractor requires other people to do their work and when he requires possession of parts of the site and consents, etc..

If the programme was submitted as part of the contract, it is assumed to have been approved when the contract was awarded. If this is not so and the project manager does not approve the programme, he must give his reasons and the contractor must resubmit within the period stated in the SCD. The regular updates of the programme now required are specifically to show the actual progress achieved on each activity and its effect on the timing of the remaining work.

iii) The project manager can ask the contractor to submit a quotation, in the form of a revised programme and revised costs, for completion of the contract before the current completion date.

iv) The NEC lists several 'compensation events' that can give rise to increased cost and/or delay. These are very similar to the causes of claims incorporated in ICE5. When a compensation event takes place, the contractor must give quotations for each possible method of dealing with it. These quotations are to be in the form of a revised programme, changes to the prices and to the completion date. If the quotation is accepted, this also means that the revised programme and completion date have been accepted. Failure by the contractor to provide quotations means that the project manager must make his own assessment.

v) Provision is made for the employment of an adjudicator to resolve disputes between the parties, and it is intended that this method should be adopted for dealing with all such disagreements. Arbitration is still available as a last resort should either party be sufficiently dissatisfied with the adjudicator's decision.

The New Engineering Contract is undoubtedly an original and some would say long overdue approach to the problem of construction contracts. By providing a new form that can be readily adopted to suit the variety of types of contract now in use in the industry, it may well be seen in future years as a major breakthrough. One of its stated aims is to stimulate good management by incorporating the principles of project management. This should surely mean that the importance of time and programmes ought to be given more prominence in the use of this new document. As with ICE6, the likely effects of the NEC on this aspect of contract administration will now be considered:

i) Perhaps the most important revision is the new way in which compensation events are to be dealt with. It appears that acceptance of a quotation may limit the project manager's future actions. If the real costs and effects on completion time are not in line with the quotation, the project manager must presumably live with his decision. Further compensation events that affect the contract could perhaps be dealt with in the light of later information, but if there are no further compensation events then there would be no opportunity to redress the balance. In effect, this new approach seems to sacrifice an accurate assessment of the real situation for a solution that allows the contractor more certainty as to his position. There will, however, still be a need for project managers to assess the effects of delays when considering contractor's quotations. It is easy to imagine that such quotations may appear excessive to the project manager, simply because the contractor is being expected to price an outcome he cannot clearly foresee. There may also be problems with identification of exactly who is responsible for a compensation event, leading to the project manager not being willing to accept any quotation. Such disagreements are certainly not uncommon with current forms and will surely continue with the new one.

ii) The programme submitted by the contractor under the NEC is specified in much more detail than that required by ICE5. It should be recognized, however, that the contractor need not declare the logic of his programme. To ask for the order and timing of activities to be shown does not mean that dependencies assumed in the plan must be illustrated. This surely is a surprise. If the principles of project management are to be paramount, one would expect that the contractor would have to portray his programme together with the logic network. Other aspects of the programme are, however, more consistent with these principles. For example, the fact that regular updates can be demanded that show actual progress achieved on each activity and the effect on the timing of the remaining work. The imposition of time limits on the provision of initial and revised programmes is in line with the new approach adopted under ICE6. However, ICE6 also puts a time limit on the engineer's approval of the programme. In the NEC, this is presumably covered by the employer inserting a general period for reply to the contractor's communications in the SCD. But if this were not filled in?

iii) The fact that the employer states that he is willing to take over the works early will presumably allow the contractor to budget for lower insurance costs. Once the works are taken up by the employer, the insurance cover the contractor must maintain will be drastically reduced. It is not certain what other effects this condition might have. Presumably, if the contractor wishes to finish early, the employer will still be required to find the necessary funds as and when they become due. It is also expected that delays to the contractor, even though they are not likely to delay the project beyond the completion date, may still merit additional overhead payments.

iv) The incorporation of data to define adverse weather for the contract is a step forward. In the new regime, once weather has been worse than these parameters in any calendar month, the contractor will be able to notify the project manager that a compensation event has taken place. This would affect the recommendations made in chapter 3 of this thesis, but not fundamentally. It may still be necessary to use some arbitrary method of pinpointing the specific days that could be described as adverse. The NEC recognizes exceptionally adverse weather as giving rise to a compensation event. Unlike ICE5, however, it does not specify that this event only gives rise to a claim for delay without increased costs. If it is accepted that this is not simply an oversight, then the main source of delays type N may have been eliminated. Is the delay to be considered as one for which the employer is responsible in terms of both time and cost? The answer to this question is not clear.

CHAPTER 7

OVERVIEW OF INFORMATION SYSTEMS

The interest in information systems, and in particular those systems set up specifically for recording aspects of a construction site's progress, stemmed directly from the initial wish to study the use of programmes during construction. Having once begun to set up methods of studying programme use, the methods of keeping records seemed immediately to have to be dealt with at the same time. So closely linked were these two themes that the structure of the current thesis might easily have been written without the subdivision into two parts which is its final form. The decision to make the split was actually taken because of the different approaches used in the two sections of the work. In some parts, in fact, the subdivision is difficult to sustain. As we shall see, there is often a price to be paid for any attempt to categorize and improve accessibility.

Everyone who has been involved in an organization or project of substantial size will have been exposed to a management information system. They will often have been concerned with preparing or providing data as required by that system. An initial response to this task may well be uncertainty as to just what the information is to be used for. However, providing the effort involved is not too great, the task will be carried out with reasonable accuracy and efficiency and little extra thought as to its merit. The general assumption is that the people who have set up the system have done so with a full awareness of how the results are to be used. This view does not last long and is soon replaced with a much more popular scepticism as to the value of these systems. This will often be coupled with a suspicion that management probably intends to use the data collected to find fault; either with lower levels of management, the work force or both.

The combination of an interest in the use of programmes during construction, and the work done on a construction site trying to identify these uses and eke out the problems, led to the idea of developing a new form of record-keeping software for construction sites. This is described in detail in chapter 9. It was to assist in the development of this program that the need to understand the difficulties encountered with information systems arose. Much of the research in this area relates to organizations set up, not just to complete a single project, but that are likely to exist on a much more long-term basis. Clearly any findings from such research must be carefully analysed before being adopted as relevant to the rather different site environment.

As well as commenting on the above, this chapter lists the various types of information commonly held, together with identifying some of the problems resulting from categorizing information. Also, specific differences between most organizations and construction sites are noted which may well affect their record-keeping systems.

What information and why?

Most research into the difficulties encountered with information systems considers only those systems set up to allow management to assess the productivity of individuals or sections of an organization. This is done so that management can be aware of what is going on. It aims to provide them with the data necessary to identify areas in the company where performance in some measure is below standard. This obviously requires that the information relates to a measure of production that can be compared to accepted standards. It presupposes that there is some action which management can take to rectify any unacceptable situation. Although the proposed new method of keeping information is not intended to be used as a control tool, it is quite possible that the people collecting and compiling the data may think otherwise. It is also possible, as the information which will be made available by the new system could be used in this way, for management to adapt the data for this purpose. Thus, it is helpful to understand any dysfunctional ways in which employees may respond to systems that can be used to assess their own performance.

Of course, information on the organization's activities will be held for several purposes other than assessment of productivity, and it is important that the variety and complexity of such information is understood. Amongst these additional records will be:

i) records kept to provide the basis for balance sheets and profit and loss accounts that are required to be audited annually;

ii) records of individual accounts of debtors and creditors, to ensure that monies owing to the company are paid and that outstanding debts to suppliers are not allowed to involve the organization in litigation;

iii) personnel records kept to ensure proper payment is made to employees and that such matters as training and disciplinary measures may be competently dealt with;

iv) results of any tests on the organization's products to verify conformance with accepted standards;

v) records to certify that proper procedures have been adopted (quality assurance records).

The list is not exhaustive and, as well as other areas in which records will be kept, there will no doubt be many cases in which several different sets of records are kept on each of the categories listed.

The collection of this mass of information is of course in part justified by the essential uses to which some of it is put. It is, however, often found that when management wishes to access this data to aid their decision-making, that the information needed is not available. That is to say, not readily available, although it may be possible to produce the information by analysis of existing data, given the time and manpower necessary for this process.

Construction sites, as has already been noted, are in some respects not directly comparable with most other types of organization. As an arm of larger companies and bodies (consultants/contractors/local authorities, etc.), they will obviously need to hold similar information to that just described. They will, however, also need to keep records on other matters. These will be considered in some detail in the next chapter.

Classifying information

The value of the information held by an organization will depend on its accessibility and on whether it is arranged in a form which makes it useful. On a more general level, this is demonstrated by the fact that lists of customers for certain types of products or services may be very marketable to other companies wishing to direct their advertising at the most susceptible sectors of the population. As we have seen, most organizations will already have large quantities of information that they have recorded and continue to record concerning their activities. If it is considered worthwhile to modify this data by categorizing or synthesizing in some way to make it more useful, then it would surely be sensible to do this as the information becomes available, rather than later. The option of performing these operations by computer would speed up the process, but it is considered that often computers would not hold the solution. This is because the classification will often demand some element of judgement.

Of course, not all information needs to be modified and sometimes it becomes available at odd times and without any easily identifiable pigeon-hole in which to preserve it. In such cases, and research is typical of this, the important thing is to record the information and decide what to do with it later. Such a system was adopted to record important ideas as they arose during the course of the current work.

It can be argued that all information becomes inaccurate as soon as we begin to classify it and adopt it for our own purposes. A simple record of the hours worked by an employee may well be an accurate reflection of the time he spent on the premises (although even that may sometimes be in doubt). However, when we begin to use that information together with records of his output to gain some impression of productivity, we immediately make assumptions that may not be true. It will be expected that the day of the week will make no difference to his output, but this may not be correct. It could be that valid records for this purpose would need to indicate the effort exerted and the difficulties he encountered in carrying out his normal duties on any particular day. Clearly, such matters will not concern us if we are wishing to derive average information about productivity. The 'swings and roundabouts' principle will hold. However, when information is reclassified into categories to aid accessibility or usefulness, there is a real possibility that additional errors will arise, or that information will be lost or degraded. This is illustrated by two examples: one from the literature and the other from recent work on construction sites.

Brian Fine (47) has conducted a number of tests on the accuracy of estimating in the construction industry. In one such test to assess the quality of cost accounting data, he set up an experiment to see how well cost accountants allocated details on time sheets to cost codes. This is a standard method of categorizing data on construction sites with the aim of providing useful information for site cost control. The results showed that:

i) with 30 cost headings, about 2% of the items on the test time sheets were misallocated;

ii) with 200 cost headings, about 50% of the items were misallocated;

iii) with 2000 cost headings, only about 2% of the items were correctly allocated.

If these results are at all typical, the inaccuracies built into the new cost data (which in the normal course of events the contractor would not be aware of) would make any decisions made based on this data of doubtful value.

The second example arose, as stated, from visits to sites carried out as part of this work. In discussing the type of records kept by the resident engineer's staff on the site, it was revealed that a standard record sheet had been devised for the inspectors' daily log. This was an attempt to standardize the way in which information was recorded. Although accepting the new procedure, some inspectors felt the need to keep a separate record, as well as the one on the standard sheet. They did this because they believed that they could not record all that needed to be recorded on the new form. The suggestion here, is that any inspector not keeping separate records was perhaps allowing information to slip, which without the new forms would have been captured.

There seems then, to be some relationship that we need to consider when handling and manipulating information, between accessibility, accuracy and usefulness. It is tempting at this point to draw a very general graph to illustrate this, but it is probably not justified and can be adequately summed up as follows:

> If we must make our information more accessible, we are likely to have to pay something for this in terms of accuracy. This probably means that there will often be some half-way house between accuracy and accessibility at which the information becomes at its most useful.

These difficulties, however, must not be allowed to deter us from modifying raw data when this is necessary to provide vital information, either to control activities or to aid decision-making. We must, of course, be aware of the pitfalls. The classes into which we subdivide data, if this is the process adopted, should be kept to a minimum. Each class should be so well defined as to make allocations of raw data as unambiguous as possible. The record-keeping software developed as part of this research requires that information be classified into sub-groups. Although the number of sub-groups is not easily modified, the need to define these classes well enough to reduce error has been assimilated.

Failure of information systems

As has already been intimated, management information systems have been criticized by a number of writers. Lawler and Rhode (48) sum this up in the following way:

> 'A large body of research suggests that information and control systems often fail to accomplish their purpose. The systems are often fed invalid data by the members of organizations and they often cause other dysfunctional behaviour.'

There is also the suggestion that information is produced, simply because it is possible to do so, which Bentley (49) comments on, as:

> '....however, unlike a factory which produces goods according to demand, the office produces information almost at will, frequently not on demand, but because the production processes can easily produce that information. Whether or not it is needed is another matter altogether, and not one that is often examined in any depth.'

The image of the manager regularly confronted with reams of computer-generated figures, which are intended to provide valuable information to assist him, but that too often merely help to confuse and bewilder him is a common one. Given sufficient time to study the data, together with additional information on how it was compiled and exactly what each row of figures represents, much might be gained from this process. However, this extra assistance is often not as readily available as the figures themselves.

Having considered some of the ways in which information can be unintentionally impaired by categorization, the behavioural problems associated with information systems will now be considered. These may result not only in invalid data being intentionally reported, but also in goals and motivations being changed by the system. The difficulties encountered, and these are taken to apply specifically to control systems, are usually presented as:

i) Rigid bureaucratic behaviour
ii) Strategic behaviour
iii) Invalid data reporting
iv) Resistance

i) Rigid bureaucratic behaviour: here the employees, who are aware of the measures by which management intends to judge them, behave in ways that are designed to look good in terms of those measures. Thus if total sales is the parameter used to gauge performance, the employees organize themselves in such a way as to ensure that these figures are profitable for them. However, when this results in an over-emphasis on one aspect of the job to the detriment of other aspects, the overall result may be dysfunctional as far as the main goals of the organization are concerned.

ii) Strategic behaviour: in a similar manner to the above, employees act in such a way as to influence the information system results, but not necessarily to their short-term advantage. The objective may be for the work-force to achieve their aims, while producing figures to the system that are acceptable to management. This is sometimes known colloquially as 'working the system', and is illustrated by the following example. A gold mine, which would be shut down by the owners if the yield per tonne of ore mined dropped below a certain level, continued to work for several years at marginal efficiency. This was achieved by the local management using a very rich pocket of ore when necessary just to make the required yield. The local management and work-force accomplished their aim of continued employment, but the result was dysfunctional for the owners. They would have been better served by mining all the high grade ore and then closing down the mine early.

iii) Invalid data reporting: this has been found to occur in a number of situations. The provision of estimates is one such, where the negative sanctions for missing a tight budget are likely to have more impact than the rewards for making a tight budget. When management responds more forcibly to condemn failure than to praise success, the pressure to ensure that any estimate is on the safe side can be easily understood. Other reasons detected for invalid reporting include covering up errors and poor performance, and attempting to make the system look bad to discourage its use. It appears also, that people seem to feel justified in feeding systems invalid data when they are being evaluated on measures they cannot influence by normal job performance. The unfairness of the situation seems to justify their presenting false data.

iv) Resistance: the incorporation of a new control system may be resisted for many reasons. Amongst these are listed:

a) Control systems can automate expertise and may make superfluous certain skills which people have been respected for having. Those who manage the system gain power as a result.

b) Most systems will have the potential to measure individual performance more accurately than was previously possible, and this may be seen by some as threatening their job security.

c) The system may be seen as intrusive and likely to reduce opportunities for intrinsic need satisfaction by reducing autonomy.

As previously stated, the record-keeping program that has been developed is not intended as a control system. It has, however, also been pointed out that the information it will make readily available could be used for such purposes. Even when this is not so, and when such obvious rewards as pay are not directly on the line, Lawler &

Rhode (48) report that people will sometimes present invalid data. They explain this phenomenon by noting that behaviour may be thought of as influenced by expectations about what will happen. Anytime information goes to someone else, there is the potential that it will be used for reward or punishment purposes.

Information, much sought after by management, can thus be disorientating or threatening to the employees on whom management relies to provide the data. To attempt to overcome these difficulties, we must first understand how they arise and then try to deal with them in the particular case.

Construction sites

A detailed analysis of the particular types of records kept on construction sites must wait for the next chapter. However, it is considered important at this stage to examine generally, some of the ways in which construction sites differ from most other organizations and how this might affect their record-keeping systems. Some of these points have been alluded to earlier, but will now be considered in more detail under the following headings:

1 Temporary nature of sites
2 Single project basis
3 Contractual aspect

1 Temporary nature of sites

The teams of people brought together to organize and supervise the work of construction may well be working together for the first time on that site. Some of them will often not have worked on a site before, although these will typically be the junior members. This may result in differences of opinion amongst the senior staff regarding what needs to be recorded and how. It is quite possible that the newcomers to site will not get any instruction at all as to the records they should keep on a daily basis, being left to decide for themselves. Of course, this need not happen. When the head of the site organization, R.E. or site agent, has strong views about these matters or the companies have proper laid-out procedures, the chances of a consistent record of progress being kept may be good. It should not be forgotten, however, that a lot of site work requires a quick response to a whole variety of problems. This environment, most unconducive to study, is more likely to be one in which people learn from experience, rather than learning before the fact.

2 Single project basis

Having a single, reasonably well-defined project on which to keep records, rather than a number of diverse and separate activities, should certainly simplify matters. It is, however, important to realize that the nature of projects, as opposed to most process-orientated industries, means that records of work today, if not safely captured, cannot be relied upon to be available in similar vein tomorrow. The record thus needs to be continuous and complete in a way that is not so evident for non-project type work. Also, exactly what needs to be recorded will, in some circumstances, not be clear. Experience and judgement will then be needed to understand what is important and what is not. As has been previously noted, that experience will not always be available.

3 Contractual aspect

Surely the most noteworthy facet of construction sites, when considering record-keeping, is that there will usually be two main parties represented. One will be operating under a contract to construct the project, with the other supervising that work. As with all contractual matters, unless otherwise stated, comments will refer to a typical contract operating under ICE5 and will assume one main contractor whose work is supervised by a resident engineer. Apart from the obvious records needed to be kept to ensure that proper payments are requested and paid, and that proper materials are adopted, many opportunities arise under these conditions for claims for additional payment and time. Whenever possible, joint records should be agreed between the two parties if it is known that additional payments will have to be made, but this is not always possible. It is for this reason that each party will typically require all its supervisory staff to keep a daily record of what happens on the part of the site for which they are responsible. Because we do not always know what factors may lead to a claim being brought by the contractor against the client, these records must attempt to provide all possibly relevant information.

It is true that most site claims are resolved without recourse to arbitration. However, when the engineer rules on a contractor's claim, he will do so in the light of his and the contractor's records. Anything that cannot be substantiated from these sources, and the relative quality and detail of the two sets of records will define the truth for this purpose, will not be payable. Clark (26), writing about the American experience of claims assessment, states that this process should simply be an attempt to predict the decision that would be made by a court if the question was presented to it. Claims in the U.S.A. are more likely to be heard in a court than in a private arbitration which is the U.K. practice. However, the principle that arguments presented by the engineer on a claim should mirror those arguments that would be acceptable in legal surroundings surely stands. If this is the case, then the test of records in this area must also be governed by what would be acceptable in law. Of course, whenever the actual Conditions of Contract define the position exactly, there will be no need for such general principles to be adopted.

In the area of delays and extensions of time, however, this is certainly not so.

Site records then, may have to be presented at an arbitration hearing. However unlikely this may be, the professional engineer should ensure that his records, and those of anyone responsible to him, would be acceptable in such surroundings. Total disclosure of records can, of course, be required by the arbitrator. Thus it is not only those records which a party wishes to make use of which should be in good order.

CHAPTER 8

RECORD-KEEPING ON CONSTRUCTION SITES

Following the general overview of information systems contained in chapter 7, this chapter will concern itself with those records that might be expected to be found on a typical construction site. In the first section, the records kept by the two main parties on site will be considered in detail. This will be followed by an analysis of the questions on record-keeping addressed to the interviewees in the questionnaire survey. Finally, there will be a review of the problems that inhibit the provision of a good, accurate record of the site work and of how these records sometimes fail to provide the required information. The source of data for this last section is twofold: part is supplied from the literature, the rest stemming from the ideas generated during the course of this research.

The records kept by the two main parties

As in other parts of this thesis, the expectation is of a main contractor supervised by a resident engineer on a contract governed by ICE5. The two main parties in question are thus the contractor and the resident engineer.

i) Records kept by the contractor

The most comprehensive source of information regarding the contractor's typical records was found in Major & Ranson (24). The records generally kept were said to be as follows:

Records of labour: including wage sheets; record of numbers of men on site; total hours worked on a project; non-productive hours; average hourly rate.

Plant: returns usually made weekly

Monthly financial report: amounts applied for and paid on valuations; claims and expected settlement accounts; claims against contractor; forecasts of total payments to be received from the project; actual costs to date & anticipated at completion; details of delays and extensions applied for.

Progress Records: said to be kept in some form, but all too commonly not maintained or modified part-way through. Progress meetings held at regular intervals will yield minutes but are said only to provide a broad picture of progress.

Monitoring both the financial position of the contract and the physical progress of the work are seen as the prime reasons for the contractor to keep records. Secondary reasons are given as identifying unsatisfactory progress and producing evidence of additional costs where these are recoverable from other parties.

ii) Records kept by the resident engineer

The source used for information under this heading was the South Yorkshire County Council Procedure for Contract Supervisory Staff (50), sometimes known as the resident engineer's bible. In this document, the resident engineer is expected to keep the following records:

* weather;
* accidents, 3rd party claims, staff attendance, land entry, visitors and roadsigns;
* unforeseen and unusual occurrences;
* photographic progress record;
* plant & labour returns;
* copy of contractor's wages sheet;
* plant disposition;
* delivery of materials;
* dipping records (to pavement layers);

* Public Utilities' works;
* dates of issue of drawings;
* concrete pours;
* progress chart.

The diaries kept by the technical staff on site are to record:

* weather;
* drawings issued;
* setting out checked;
* verbal instructions given;
* record of Variation Orders;
* detailed measurement of covered work;
* nature of soil;
* cause & duration of stoppages & alterations in rate of progress;
* particulars important in the settlement of disputes;
* materials deliveries;
* transport employed;
* plant employed including length & cause of idle periods;
* other information to record progress;
* start & completion dates of parts of the works;
* names of visitors.

Attached to the document are standard forms provided to record:

* Public Utilities works;
* carriageway surfacing;
* dip sheets (to pavement layers);
* supervisor's weekly report;
* weekly progress report (to headquarters);
* roadworks report (traffic diversions);
* financial forecast.

It is also confirmed that correspondence between the resident engineer and the contractor's agent must be seen as a part of the contract records, and that an as-built record will be produced at the end of the work.

Clearly, in this text, a good deal of effort has gone into trying to ensure that the site staff produce comprehensive documentation on various aspects of the construction. It is certainly often argued that one of the most important functions the resident engineer and his staff perform is the keeping of this record. A number of questions were put to the interviewees in the questionnaire survey concerning the type and quality of records kept and these will now be considered.

Analysis and discussion of questionnaire results on record-keeping

(Questions 37-42 from the Engineer questionnaire and questions 29-34 from the Contractor questionnaire refer)

The questions to be dealt with under this heading can be seen as falling into two categories. In the first category, the way in which site staff keep their personal records is investigated. A common approach to keeping records on site, whatever other systems are adopted, is for each individual to be required to document activities in their own areas of responsibility. The questions addressing this area are numbers 37 - 39 on the Engineer questionnaire. Very similar questions are to be found on the Contractor questionnaire. In the second category, the questions are more general and directed at the total record kept by the Contractor or Engineer. These are questions 40 - 42 on the Engineer questionnaire and are reproduced verbatim on the Contractor questionnaire.

Concerning personal records, the three questions aim to identify the form in which that record is kept and whether any guidance exists on the content of that record and on its layout. The most popular format was undoubtedly the bound page-a-day diary. This was used very widely by the Contractor's site staff and R.E.'s engineers, whereas there was a tendency for the inspectors working for the R.E. to use another form. Either standard record sheets or a loose

Analysis and discussion of questionnaire results on record-keeping

(Questions 37-42 from the Engineer questionnaire and questions 29-34 from the Contractor questionnaire refer)

The questions to be dealt with under this heading can be seen as falling into two categories. In the first category, the way in which site staff keep their personal records is investigated. A common approach to keeping records on site, whatever other systems are adopted, is for each individual to be required to document activities in their own areas of responsibility. The questions addressing this area are numbers 37 - 39 on the Engineer questionnaire. Very similar questions are to be found on the Contractor questionnaire. In the second category, the questions are more general and directed at the total record kept by the Contractor or Engineer. These are questions 40 - 42 on the Engineer questionnaire and are reproduced verbatim on the Contractor questionnaire.

Concerning personal records, the three questions aim to identify the form in which that record is kept and whether any guidance exists on the content of that record and on its layout. The most popular format was undoubtedly the bound page-a-day diary. This was used very widely by the Contractor's site staff and R.E.'s engineers, whereas there was a tendency for the inspectors working for the R.E. to use another form. Either standard record sheets or a loose leaf diary would be more likely to be adopted by them. Question 38(E) asked whether any standard advice existed concerning the content of these records. The response from both Engineers and Contractors was very similar. About a half confirmed that such information was made available while the others relied on other methods. These were: use of standard record sheets with pre-printed headings; an aide-memoire bookmark; senior staff instructing junior staff, or reacting to bad practice when this was identified. When asked about the layout of the personal records, the response was generally that no specific advice existed. However, those organizations using standard record sheets pointed to the headings on those sheets as defining the layout.

When asked to say how days lost due to adverse weather were recorded (Q40(E)), both Engineers and Contractors replied in a similar manner. Both said that either the R.E./Agent or all of the site staff would make a note of days lost in this way. This would be followed by an attempt to agree the facts between the two parties at the progress meetings. One interviewee said that days lost in this way were recorded 'quietly', presumably because they might affect a subsequent claim for an extension of time! The next question in this second category queried whether any record of progress was made in terms of the specific activities identified on the contract programme. The computer program written to keep records and described in the next chapter is designed specifically to keep such a record. It was, therefore, very interesting to find out whether such a record was thought to be useful and for this reason already kept. The responses were varied. Two Engineers and two Contractors said that such a record was not maintained but the rest replied more positively. A weekly or sometimes monthly report on percentage completion was made by a number of respondents, although it was not clear whether this was on all activities or just the main ones. Two Contractors also added that they noted if a gain or loss had occurred in the activities' progress. Clearly control was seen as the main reason for supporting this record by these two.

The last question attempted to identify how satisfied the two parties were with the quality of the site records produced. This was achieved quite crudely by asking the respondents to choose between: very satisfied; quite satisfied; not satisfied. The sample tested was not large, but nevertheless it appeared that in general the Engineers were more satisfied with their records than the Contractors were with theirs. Some of the comments made were quite interesting and tended to recognize the possibility for improvement. Engineers' records were said to be '....some good, some not so good...' often because the engineers involved were learning. Senior staff in the Engineer's organization were said by one respondent to be virtually office bound, even though they were on site full-time. Of the Contractors, one said that it was very difficult to get people to do things right, one was never satisfied, while another said that he never had enough staff. This last respondent added that they regularly '...get beat 5 - 0 by the R.E.!'

The personal records kept by (say) the resident engineer's staff on a major construction site can be very extensive. For each year that the site is active, each member of the engineer's staff will produce a diary and there will also typically be a number of lever arch files containing the inspectors' records. All these records will usually be handwritten with varying degrees of legibility and possibly adopting different layouts and concentrating on different aspects of the works. For certain parts of the job, where works have been varied, detailed records on a dayworks basis will probably be kept. However, for most of the unamended construction, the personal records will be the major source of information. Any more general record of progress produced is likely to have originated from the diaries as the basic data source. It is, therefore, very important that these records are as comprehensive, complete and accurate as possible. They need also to be accessible. It is common for engineers to want to extract from these records details of when a particular aspect of the construction was underway. If the records cannot be easily interrogated in this way, then they lose some of their value.

The different methods of storing an individual's personal record are likely to have advantages and disadvantages in terms of completeness and accessibility. The bound page-a-day diary, although limiting in the amount of space made available, otherwise gives maximum freedom as to the content and layout of those records. In the hands of an experienced and responsible engineer, the record kept in such a format should be not only comprehensive but also accessible. A system using standard headings, on the other hand will ensure that the records produced are accessible but may limit the areas covered and the amounts to be recorded against any one item. The experienced engineer will no doubt also produce a good record even with this system. The problem comes when inexperienced engineers are responsible for keeping the record. When using the bound page-a-day diary, junior engineers may fail to document aspects of the day's work or may not lay out their diary in a way which makes it easily accessible. Quite possibly, the format adopted may change as the engineer learns more effective means of presentation. The use of standard record sheets, however, may also have limitations. Once something has been recorded against each heading on the sheet, the engineer may believe that his duty has been done. Matters which do not fit easily into any of the categories on the sheet may not be recorded for this reason. It is also possible that if the sheet is not specifically written for the contract at hand, that the categories may be too general to allow sensible allocations of information.

On sites where the quality of the records made is recognized as important, the senior site staff will no doubt make efforts to instruct the junior engineers. This, however, is not easy to do. How, for instance, are these engineers to be taught to recognize unusual occurrences or matters that might be important in the settlement of disputes? Most of them will not have been on site before and will not be aware of how disputes generally arise or of what normally happens during the construction process. To have an ongoing review of the quality of these records by senior staff is clearly essential (quality control), but it is also clear that if failings have to be corrected, then a substandard record of a part of the works has already been made. Fortunately, more than one engineer will often be keeping records of what happens in any particular area. Where a senior engineer is also keeping a record of the same activities, failings by the younger engineer will not be so crucial. However, from the survey it appears that sometimes the senior staff are almost office-bound. This is a worrying development when the engineers with the experience are unable to find the time to get out on site at least once a day! The problem of ensuring that a good record of construction is achieved is a difficult one. Engineers need experience to realize how important records are and what needs to be recorded; to get that experience, they must be employed on construction sites! Having got that experience, they may find that their workload makes it very difficult for them to tour the site, even though they are resident there.

The previous comments lead to only one conclusion. This is that the keeping of records on construction sites should be included in any quality assurance scheme operated by the Engineer organizations, in particular. The employer, who relies on the standard of these records to identify valid claims and to refute bogus ones should be insisting on such an approach being adopted. This will not ensure that records will always be of the desired quality, but will at least show that management has made every effort to achieve this. None of the Engineers or Contractors interviewed said that they had any quality procedures covering this area.

There was good agreement between the Contractors and Engineers concerning the handling of data on days lost due to adverse weather. These days are logged by the two parties and an attempt made to agree the facts regularly at the progress meetings. It is also common practice on many sites to record temperatures and rainfall daily. With this information, it should be possible to identify the combination of weather that typically stops work on site. By inspecting past weather records, the question about whether the contract weather was in any way exceptional should be able to be resolved.

Most of the respondents, both Engineers and Contractors, confirmed that they did keep a record of progress in terms of the activities on the contractor's programme. As this matter relates to the computer program written for keeping such a record, it will be considered in more detail in the next chapter. For the moment, however, it can be said that most of the responses indicated that this record was updated at weekly or monthly intervals. Many also said that they were recording percentage completion, and not necessarily of all the activities on the programme. For most, it seems unlikely that a daily record of all activities was being maintained.

The final question on how satisfied the interviewees were with the quality of their records produced what might have been seen as a predictable response. The Engineers, for whom record-keeping is recognized as a very important aspect of their work, confessed themselves generally quite well satisfied. The Contractors, on the other hand, appeared less confident. Undoubtedly their main concern is to construct the works adequately while controlling costs. Good records, although at the end of the day essential to ensure that proper remuneration is received, must seem a secondary matter in the hurly-burly of construction. Of course, these results do not prove that one set of records is better than another; simply that the perception of those records by the parties is different.

Problems in record-keeping

Most writers who deal with claims and disputes on construction sites will recognize the difficulty of obtaining good, accurate records in the form required. The importance of these records is stated particularly memorably by Abrahamson (2), who says:

> 'A party to a dispute, particularly if there is arbitration, will learn three lessons (often too late): the importance of records, the importance of records and the importance of records.'

He recommends that:

> 'Obviously there should be concentration on collecting "real" first-hand evidence while it is fresh, by way of photographs, tests, etc., as the works proceed rather than on argument and confusing and increasingly strident correspondence by which each party concentrates more on trying to build the file than the works.'

A suggestion offered is that:

> '....both contractor and engineer should have an established procedure for record-keeping that will work more or less automatically and painlessly to produce the minimum records necessary.'

In discussing the form in which records are likely to be available, Major & Ranson (24) state:

> 'It is at least unusual for such records (progress records) to be in a form that will enable a detailed analysis of actual progress of work to be made. Where it is necessary to make such an analysis there are a number of sources that are likely to be available, but invariably a considerable amount of investigation is

> required in order to establish what actually happened on a project.'

During the period of study for this thesis, and especially during the time spent on weekly visits to construction sites, a number of particular areas of difficulty were recognized. These will now be listed, as follows:

i) In trying to document when an activity actually takes place there may be problems in recognizing both the start of the activity and in recognizing its end. At the start of some activities, there may be a period of setting up when no output of completed works is achieved. Nevertheless, the preliminary works are an essential prerequisite to the activity itself. In such a situation there needs to be recognition that these non-productive elements should be recorded as a part of the activity which they precede. Even the end of an activity will sometimes be difficult to define. It is common for contractors to complete an activity only to the level at which subsequent activities can proceed, or to the level that would be acceptable for a certificate of completion. The work necessary for finishing off these activities will be done later or even in the maintenance period. Any record that purports to relate to progress and that will be used to assess delay claims will need to recognize such behaviour. As delay claims will principally relate to the time when a certificate of completion is issued, it can be argued that the level of completion of all activities needs only to be what would be acceptable for the issue of that certificate.

ii) The work of the main contractor and his subcontractors is clearly of greatest interest to the site staff. It is that contract with which they will be most familiar and any contract with other contractors on the site will often be given less attention. Contracts with public utilities for services diversions are typical of the work of these other contractors. While the form of contract with these contractors will probably not need such copious records to ensure that proper payment is made, that does not mean that a good record of their work will not be needed. Whenever another contractor, not a subcontractor of the main contractor, is on the same site, the possibility of interference with the timing of the main contract should not be overlooked. Adequate records of the work of these other contractors must be kept. It must at least be possible to tell when the other contractor was on site and to be aware of any delays caused to the main contractor. The keeping of such a record is noted in the first part of this chapter in the document from S.Y.C.C. (50). However, from the author's previous experience and from the experience gained on the construction sites as part of this work, it appears that this may well need to be stressed to the site staff working for the R.E..

iii) It has already been said that good records need to be complete and accessible. To assess the accessibility of a set of records, a test was carried out on the inspectors' records for the site visited over a two week period. The aim was to see how readily an 'as-built' record of the activities on the contractor's programme could be generated from these records. The actual weeks studied were selected at random. It took thirty minutes of hard work to define two weeks of the as-built record and even then these were not complete. Some of the inspector's sheets were missing and it was sometimes difficult to identify the activities concerned. Interpreting one day's records sometimes needed an understanding of what had happened the previous week, as comments such as 'work continues' would be written under a general location heading. In this instance, the aspects of continuity and accessibility were certainly not well served.

iv) The previous point at (iii) seems to support the suggestion that any classification of the records that will need to be carried out would be best carried out at the time the initial records are captured. This point was highlighted when writing the computer program which is described in the next chapter. At first the program was written to provide a daily record of when all activities were active. Later it was realized that a record showing what activities were underway on a weekly basis would be useful. The first attempt to produce the weekly record involved a search of the daily record to find out whether, for each activity in each week, any progress had been made.

Even at computer speeds, this was a very slow process. So much so that an alternative approach had to be adopted. This was to write to a daily matrix and to a weekly matrix whenever an activity was recorded as active. In effect, the weekly matrix was being constructed contemporaneously with the daily record. This was a direct parallel with the suggestion that records should be classified at the time they are collected wherever possible.

CHAPTER 9

RECORD-KEEPER: A COMPUTER PROGRAM FOR KEEPING RECORDS ON CONSTRUCTION SITES

As we have seen, all organizations need to keep records of their activities for a variety of reasons. It has also been recognized that the records kept by the parties on construction sites, together with fulfilling the needs of auditors, payment of creditors and pursuit of debtors, have other very important functions. Of these, as well as monitoring progress and confirming that proper materials have been used, the records kept will be the main source of information with which claims for additional payment and/or time will either be founded, by the contractor, or assessed, by the engineer. Site records exist in a range of different forms, viz. minutes of meetings, correspondence, file notes, materials delivery invoices, photographs, plant & labour returns, personal diaries, etc.. The list is not intended to be exhaustive, but simply to remind the reader of the complexity of information that may be available on any reasonably-sized site. This will often mean that most of the information that might be needed will be available, but it may not be in the most accessible form. If we need to know when the wearing course for a length of roadway was laid, for example, and this is not clear in the personal diaries, it will typically be possible to find the date from records of 'dipping' to that pavement course. The same information is often kept in a number of different forms. Some of it, however, although accessible for an enquiry about what happened on a particular day, would be most tedious to access to determine actual progress over time on the activities listed in the contractor's programme. From the first part of this thesis, the need for such an 'as-built' record to deal with delay claims has already been recognized. Those traditionally kept records, which can be thought of as progress records, will now be considered in detail to see how they might be adapted to provide the factual record needed for delay claims analysis.

Progress records

1. Personal diaries

This is an extremely important fund of information, which should be well ordered with each level within the site hierarchy well aware of just what aspects of site activity he/she should be recording. At the lowest level, detailed records of what plant and labour were used for all activities within the individual's area of responsibility should be available. At the highest level, the record is more likely to consist of notes of meetings and discussions with a much more general review of site activity.

In practice, such records are essential when dealing with the detail of claims, but as a prime source for compiling the factual record of progress, they are likely to be unsatisfactory. The effort involved in analyzing these diaries after-the-fact is considerable. This was confirmed in the attempt to analyze inspector's records reported in the previous chapter. Although most of the information may be available, the time taken to eke it out will probably mean that inaccuracies will creep into the analysis. This is to be expected even with a complete record, whereas the actual set of records is most unlikely to be complete. During holiday periods and periods of sickness, parts of the site will be reported on by different staff or not at all. The records kept will only ever be as good as the staff employed to keep them and the instruction those staff receive as to what is expected of them.

2. Minutes of progress meetings

Progress meetings will usually be held once a month when the R.E. and Agent, and members of head office staff from both organizations will come together. They will discuss any matters affecting work in hand or soon to be undertaken, and will consider current progress of the works and of any claims negotiations. Charts are often prepared for these meetings to indicate which activities are presently being worked on and how their progress compares to the expected or planned progress. On some sites, these charts may well provide the basis of the required factual network, but it is believed that what is produced on many sites will fail to provide the necessary information for the following reasons:

i) Rather than being a record of when work took place on activities, the chart is likely merely to indicate percentage completions of those activities underway at the date of the meeting. This will certainly allow starts and ends of those activities shown to be traced to within a month of when they actually took place. It will not permit days worked on a particular activity to be identified.

ii) Not all the activities on the contractor's programme may be shown, with sometimes only the main activities being plotted.

3. Daywork sheets and agreed records

The records kept for varied work on a contract are often much more detailed than the records for the rest of the contract work. This is because extra payments will be involved and the extent of the payment will be fixed by these additional records. Indeed, it is principally to ensure that proper payment may be made that these records are held at all. Although they may be helpful in identifying the durations of delays due to additionally instructed work, the fact that most of the contract work is not covered by them makes them of little use in preparing any factual record.

4. Photographs

Photographs of the site at intervals throughout the construction period will provide a wealth of information that could only be recorded on paper by making copious notes. By their very complexity such notes would be extremely inaccessible. Just as drawings convey certain types of data much more efficiently than the printed word, so photographs reveal the exact state of construction at distinct points in time. Of course, unlike drawings, these photographs are instantaneous representations of a continuously changing scene. Yet because they are only taken at intervals this means that they are of little assistance in preparing the factual network. Also, although photographs may show men working, it may not be evident as to exactly which activity they are working on.

5. Weekly progress reports

Often prepared by the resident engineer or by the supervisor or both, the main aim of these reports is usually to provide information to higher levels of management. Although the reports are called progress reports, much of what is contained in them will be to do with complaints from the public and problems likely to lead to significant increases in cost and/or delay. There will, however, be a resumé of progress on the site and this may be helpful in any attempt to compile a factual record retrospectively.

In generalizing about an industry as diverse as the construction business it is almost certain that what is said will be quite at odds with what is done on certain sites. No one individual has sufficient in-depth experience of the breadth of activities covered by the industry to be sure of avoiding such a possibility. However, this accepted, it is still believed that the preparation of a factual record of progress may often be very difficult to compile in hindsight.

In the light of these arguments, coupled with a conviction that contemporary records are always to be preferred to records assembled after-the-fact, a decision was made to write a computer program that would allow a factual record of progress on a site to be easily compiled.

Record-keeper: details of the program

As the initial aims of the program were simply to permit a record of the progress of project activities as defined by the contractor's programme to be provided, the main requirements were clearly to provide input to the program and to permit the inputted records to be displayed. It would certainly be possible to do more with such a program, but it was felt that in the first instance input and display options would be sufficient.

Input options

1. *Activity data*

The basic activities for the project need to be made known to the program and for this purpose an input routine is available to allow short activity codes and descriptions to be recorded. The descriptions must clearly relate to the activities as identified on the contractor's programme and it is suggested that codes may help distinguish between activities of different types. For example, the activity codes for all earthworks activities may begin with the letter 'E', etc.. Identifiable delays, when they become known, are recommended to be treated much as activities in this respect. Records of when delays are operative should thus be kept alongside records of work on activities.

2. *Activity progress data*

The program is set up to allow a daily record to be kept of progress on all activities making up the project. The choice of options to describe activity progress is currently as follows:

selection	*meaning*
X	activity working all day
H	activity working half day
W	activity not working all day due to weather
R	activity not working half day due to weather
D	delay effective

Thus for any activity on any day, the user can record that any of these options is the best reflection of that activity's progress on that day. Selection 'D' is, of course, reserved for delays. The choices are so far felt to be the most useful for general application, but it is accepted that different users may feel the need to categorize progress in some other way. Making changes to this aspect of the program would not cause any particular difficulty. It has even been considered that a facility to allow the user to define these choices might be worthwhile in the future. A view of the input screen used for this purpose is included as figure 9.1. To record that an activity has been worked on, the highlight is moved to the

Code	Activity Description	Input
E101	Excavate topsoil	
E102	General excavation	
E104	Excavate S. abut.	
E105	Excavate N. abut.	
E106	Backfill S. abut.	
E107	Backfill N. abut.	
R101	Sub-base W/bound	
R102	Sub-base E/bound	
R103	Roadbase W/bound	
D101	Delay No. 1	D
S102	Blind S.abut	
S103	Blind N. abut	X
S105	S. abut base	
S106	N. abut base	
S109	S. abut stem	

13:JUN:91

COMMAND OPTIONS

KEY	EFFECT
F	end input

INPUT OPTIONS

KEY	MEANING
X	working all day
H	working half day
W	not working all day due to weather
R	not working half day due to weather
D	delay effective

COMMAND ?

Figure 9.1 Input screen for recording activity progress activity in question and the relevant option chosen.

The structure of the program is hierarchical and having elected to input activity progress records, the user has two options. He may input data to a full selection of activities, which can be scrolled, or can make a selection from the full list of activities which is then displayed. Progress may then be recorded in the same way.

Display options

1. *Monthly display*

Any month of any year for which records have been kept for a contract may be displayed with this option. Currently the records for 15 activities at a time may be shown (see figure 9.2), with a scrolling facility to show more activities. As with the records input option, there is an opportunity to select that the full list of activities is displayed or to make a selection from that list and only display a chosen few. These may be presented on the screen in any order: a facility that is very useful and certainly not available with any manual record.

2. *Yearly display*

For each week in which any activity has any progress reported, this display, which adopts a time unit of a week bridge#1 1991

Code	Activity Description	JUN										
			1	3		10		17		24		
E101	Excavate topsoil		H	X								
E102	General excavation			XXXR	H							
E104	Excavate S. abut.					X						
E105	Excavate N. abut.					X						
E106	Backfill S. abut.											
E107	Backfill N. abut.											
R101	Sub-base W/bound							X	H	X		
R102	Sub-base E/bound									XXXX	H	
R103	Roadbase W/bound									XXXX		
D101	Delay No. 1					DDDD	DD	DDDD				
S102	Blind S.abut					HX						
S103	Blind N. abut					X						
S105	S. abut base							HXX	H	XX		
S106	N. abut base									HXX	H	X
S109	S. abut stem									XX	H	X

F to end

Figure 9.2 Monthly records display

instead of a day, will indicate that progress has been made. Scrolling in the activity direction is again available (see figure 9.3).

It is the intention that if RECORD-KEEPER is to be used as an index to the other site records, a function that it should fulfil admirably, then the first search ought to be made on this screen. Having found from this display approximately when the activities in question were active, it is then possible to use the monthly display to get more detailed information. This can then lead on, where necessary, to a detailed search of the site diaries.

3. *Daily display*

Although not specifically thought of as a display option, the records input screen called up for a particular day will automatically indicate any progress currently recorded against activities on that day. The purpose of this is clearly to let the user know that these records already exist, but it does, of course, double as a daily display that may be scrolled in the activity direction.

As was previously mentioned, many other facilities could be provided alongside the above. These might permit the program to be used to compare expected progress with actual progress, or to assist in providing feedback information to a contractor's estimating department. For the moment,

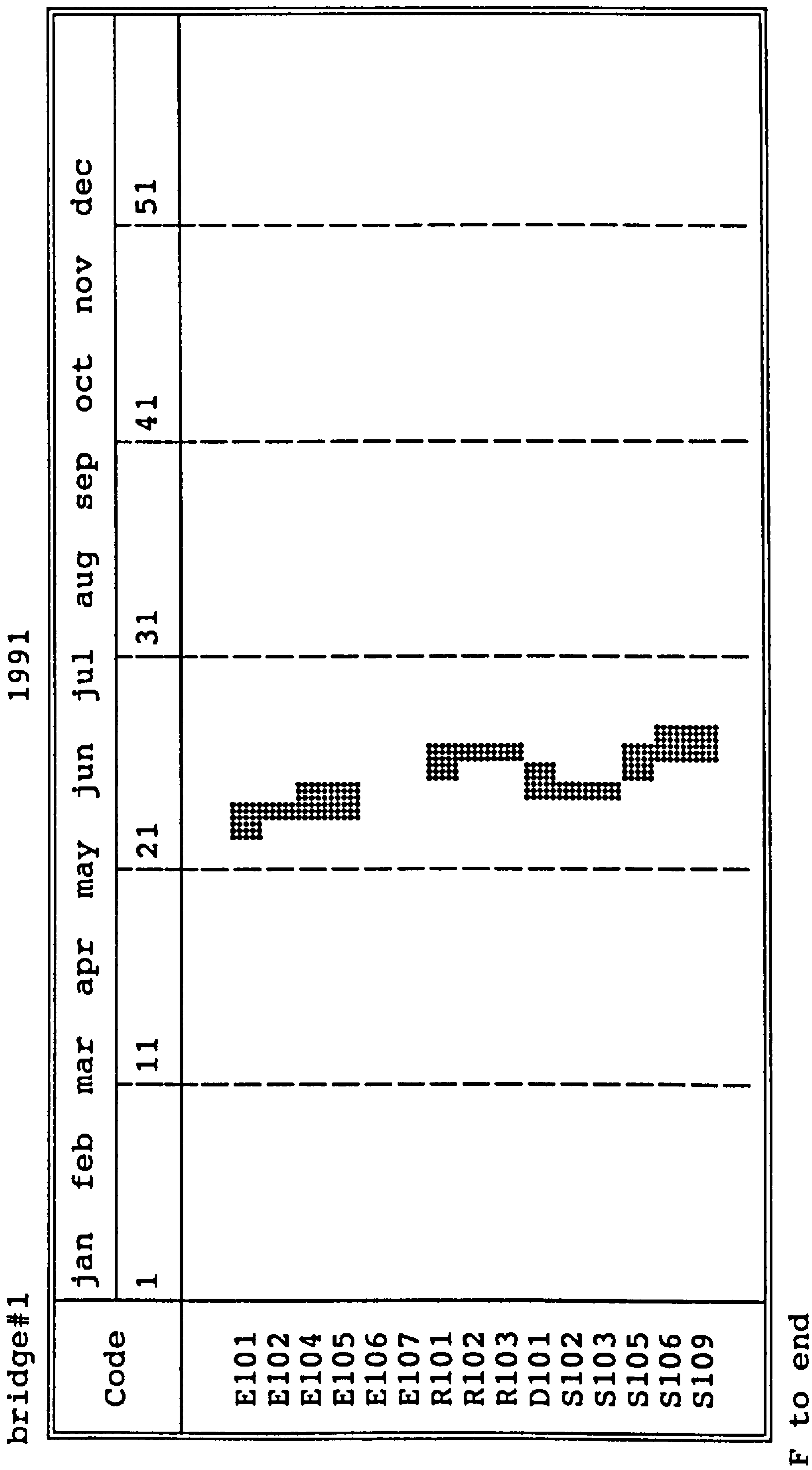


Figure 9.3 Yearly records display

however, these issues are regarded as secondary and certainly other programmes exist that will provide assistance in these areas. The principal aim of this version of the program is thus to provide a detailed record of progress on each of the project's activities and to record the extent of identifiable delays.

Use of the program

In this section, two aspects of the program's use will be considered. The first aspect relates to the procedures that it is anticipated will need to be implemented on a site where the program is to be used. The second covers the way in which the records held by the program are likely to be employed in practice.

Effect on site procedures

It is recommended that the responsibility for making the site record using RECORD-KEEPER should be given to one of the engineers in the site organization concerned. Each day this engineer would need to go round the site towards the end of the day and discuss progress with other site staff. This should be done before he records the results of his knowledge of activity progress on the computer. (It is not always possible to detect exactly what is happening on a site in just one tour, hence the need for consultation). Any new areas of delay identified should be added to the list of activities and periods in which the delay was effective should be recorded. Note that the effects of weather are covered in individual activity reports. This procedure is not expected to add greatly to the engineer's workload as most site engineers would expect to tour the site at least once a day. For the engineer concerned, this record-keeping operation might on some sites replace keeping a personal diary. On contracts where engineers find difficulty due to other commitments, in touring the site once a day, this procedure would ensure that at least one engineer made such a daily inspection.

The individual responsible would clearly need to have a good understanding of the contractor's programme and the way in which the work had been broken down in that programme. It is also believed that guidelines would be needed to lay down (say) whether a day in which work progressed for one hour before being called off for the rest of the day due to rain should be coded as 'W' or 'R'. Of course, the responsibility for keeping the record when the nominated individual was either on holiday, sick or just too busy would have to be passed onto another member of staff.

It is understood that some construction sites do not yet possess a computer, but with the arrival of increasingly reasonable prices for hardware and software it is felt that this situation is likely to change. RECORD-KEEPER will run on an IBM PC or IBM compatible: the kind of machine that with the right software can double as a word-processor and the hard-copy reports may be produced on a basic printer. At the moment, the program produces a file for each year of the contract and it is clearly recommended that these files should be backed up at regular intervals in case any of the data should become corrupted. For a contract of less than one year duration, totally completed within one calendar year, the records will, therefore, all fit on one file.

Use of the records

Three principal areas have been identified in which it is believed that provision of a factual record of progress, as provided by RECORD-KEEPER, will result in benefits to the user. These are as follows:

As an index to the main records

It has already been suggested that the factual record provided by RECORD-KEEPER may be seen as a means of referencing the large number of other sources of data held on most construction sites. During and following the construction phase, it is usual for a variety of requests to be made for an analysis of some aspect of the construction performance. Most of these will come from the organization's head office, but some will originate from the site itself. This invariably leads to a review of the main site records in order to provide the information needed. Such searches, it is suggested, will often be made simpler and quicker if the days on which each activity took place can be defined at the start.

For the resident engineer's staff on a site, keeping a record of exactly what happened during construction is often seen as one of the most important functions they perform. To provide what can become a great mass of paper constituting the complete records compiled at considerable cost with an index, it is suggested, has great value in itself.

As an aid in dealing with delay claims

Whether a claim has been presented using the American or U.K. approach to these matters (as described in previous chapters), to prove that a single delay or combination of delays has given rise to a right to an extension of time, the following is likely to be necessary:

i) an annotated account of the effects of each delay in question;

ii) identification of a succession of activities that have been shunted along by the delay(s).

In the U.K., given the situation where the contractor has submitted such a claim, the resident engineer will then have to check that he agrees with the delay effects stated. He will also have to check from his records that the succession of activities was indeed in series. Any time gap or overlap between activities in this chain would clearly have to be explained. Also, simply looking at the path through the project identified by the contractor, may result in overlooking another succession of activities through the network that also affected the final completion time. If, say, this second path existed and all delays on it were attributable to the contractor, then the contractor's claim might not be justified.

The records provided by RECORD-KEEPER are exactly those needed in this situation. It is also believed that unless this approach is adopted, the effort of trying to identify any alternative path through the network may mean that it would be unlikely to be attempted at all.

As an aid in dealing with disruption claims

When individual causes of delay are either too numerous to quantify separately, or the effect of external interference on the contractor's progress is simply to cause a loss of productivity rather than a complete halt to the work, a claim for disruption is likely to be made. To quantify his damages, the contractor will probably have to point to similar work to that which was disrupted to prove the rate of production he could achieve in normal circumstances. Although not the only records needed either to prove or to assess such a claim, the information provided by RECORD-KEEPER together with production figures and details of resource allocation would permit the value of any such claim to be calculated. Productivity on similar activities not identified by the contractor could also be more quickly assessed to give a fuller picture.

Future developments

The current version of the program, RECORD-KEEPER, is clearly only a prototype. It is still in need of a considerable amount of work before it could be thought of as a commercial package. The main concern in this respect is the speed at which the program works. Undoubtedly, if it were written in another form, the speed at which the record information could be displayed and scrolled would enhance its performance considerably. For the current thesis, however, it is the concepts behind the program that are felt to be important.

An additional feature that could be added to the program but that has not been incorporated in the latest version involves the categorisation of data. This general area was addressed in chapter 7, where two recommendations were made. These were that when classifying data the classes into which the data is subdivided should be kept to a minimum and that each class should be so well defined as to make allocations of raw data as unambiguous as possible. For this application, nothing can be done about the number of classes. That is decided by the number of activities into which the contractor breaks down the work of the project and the number of delays encountered. However, there is an improvement that could be made to the program that would help to define the actual classifications. It is believed from the site visits carried out at the beginning of this study that it will not always be possible to recognize uniquely the particular activity, defined by the contractor's programme, against which work on the site should be recorded. This being the case, all that an engineer using the program could currently do, would be to select the most likely activity and record against that. The improvement envisaged would allow the engineer to open a notebook on the screen associated with the activity against which this work had been recorded. In this notebook, the engineer would register that this work had been recorded against this particular activity. Providing that all activities could have memory aassociated with them in this way, this would allow the activities to be more fully defined where necessary as work progressed.

So far, no site trials of the program have been carried out, but it is hoped that this situation will be rectified soon. The author did, however, make a weekly manual record of the activities on the contractor's programme for the work of the construction site visited. This was effectively the same record as would have been produced using the program. In essence, the program provides a much more flexible and detailed version of the records often kept informally by site staff colouring in the contract bar chart as work progresses. As this is a recognized site activity, it is considered that replacement of that activity with another should not cause too many difficulties.

CHAPTER 10

A NEW MODEL FOR TEACHING THE CRITICAL PATH METHOD

As a member of staff in the Civil Engineering Department of the University of Newcastle upon Tyne, the author has been involved in teaching project planning throughout the period of research for this thesis. Each year a new body of students was introduced to the CPM procedure in lectures and required to go through the process themselves to produce a CPM network for a simple project. During this time, a record was made of all the ways in which the students failed to grasp the technique. This was done with the intention of tackling these aspects specifically in future lectures, in an attempt to improve the teaching process. However, there was another problem that also needed to be addressed. Having gone step by step through the CPM procedure to conclude with a completed network diagram, this image of the project plan and the other known images seemed in some respects inadequate. The dynamic nature of the project plan was felt to be poorly served by these available images. This feeling was undoubtedly heightened by or possibly even emerged as a result of the author's involvement in research in this area.

The obvious way in which an academic can contribute here is in putting across the basic technique in the most accessible and meaningful way to the students who will become tomorrow's construction professionals. This requires an awareness of the main pitfalls and obstacles to understanding that most frequently occur and the use of the most potent visual aids to make the maximum impression on those students. In the rest of this chapter, the basic method of teaching CPM will be spelled out together with a summary of the problem areas hinted at above. This will be followed by a description of a new model for teaching CPM that has stemmed from the author's dissatisfaction with currently available images.

There will be no discussion of the relative merits of 'activity on arrow' and 'activity on node' formats for CPM. The author believes that it is important to be aware of both these approaches, but that only one should be adopted for the main teaching and example sessions. Here 'activity on arrow' is adopted as this has a history of being represented in a time-scaled form.

The standard approach to teaching CPM

It is suggested that for students who have not been introduced to project planning before, that a discussion of the basic reasons for producing a project plan should precede any attempt to look at the techniques available. This will of necessity include an explanation of the control process and of the need not only to monitor progress but also to act, if necessary, on the basis of the information acquired.

Then to plunge straight into CPM is also seen as rather too hasty, and the method of planning using bar charts is suggested as the best next step in the procedure. This introduces an understanding of the need to break down a project into manageable activities, for which the contemplation of durations can become more realistic. The scheduling of these activities on the bar chart may then be explained as requiring a thought process and understanding of activity sequence that is not built into the model. Such a process, however, must take place if sensible dates are to be assigned to the various activities.

Having illustrated the simplistic nature of the bar chart as a planning tool, the scene is then set to proceed onto the CPM approach to project planning.

The basic CPM procedure

The procedure adopted here is quite standard and may be represented in the form of a number of basic steps, as:

Step 1: Break down the project into its constituent activities. Clearly this must include an explanation that the planner needs to make decisions regarding what level of activity should be adopted for the project in hand.

Step 2: For each activity, estimate the most likely duration. There is considerable scope here for explaining just what factors may need to be taken into account properly to assess an activity's most probable duration.

Step 3: Progressing from the bar chart approach, we now need to understand how the selected activities are inter-related so that this can be built into the project plan. The symbols representing events and activities must be introduced at this stage and a logic network for a simple project should be produced.

Step 4: The forward and backward pass through the network is carried out leading to identification of the critical path(s), together with an explanation of the importance of this/these path(s).

Step 5: Having explained the importance of achieving critical activities on schedule, we can now contemplate the position of non-critical activities leading to an understanding of the various types of float they may exhibit.

Step 6: An overview of the project plan now produced leads to the realization that as the only resource considered so far has been time, the plan's demand for the other basic resources of labour, plant and materials may be totally unrealistic. This, in turn, leads on to an understanding of the use of float on non-critical activities to achieve some objective with regard to resource ceilings or resource profiles. The possibility of extending total project time if the above procedure fails to achieve the required objectives may also then be introduced.

The above steps are clearly only a very brief outline of the standard approach to the teaching of CPM and must, of course, be backed up by a good deal of discussion and examples. It is also recommended that all students go through this process themselves with a practical example (possibly excluding definition of activity level and duration), as the best method of instilling the basic principles.

Some problem areas

For the student who has not previously been exposed to these principles, the above procedure is often difficult to grasp all at once. From experience, the main problem areas seem to result from the following:

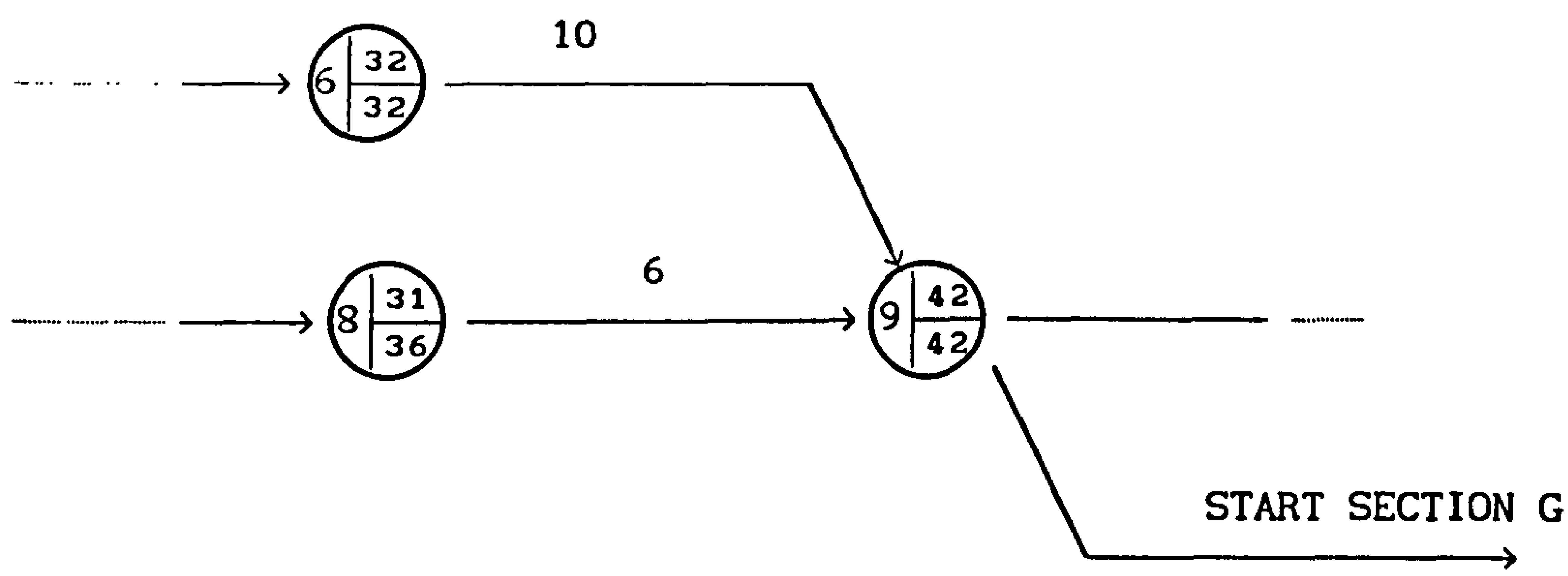
i) The student fails to understand the meaning of the symbols adopted. It is important that simple combinations of events and activities are demonstrated to make clear just how they may be used and the logic they represent.

ii) The quantum leap from a list of activities for a project to a completed logic network needs explanation. Students can get the impression that this is a simple step they are somehow unable to follow, whereas in reality, it is often the most difficult part of the whole process. Help can be given in the form of an activity list against which preceding, simultaneous and succeeding activities may be recorded or the completed network may be built up from a number of smaller sub-networks that are likely to be more easily understood. Whichever method is adopted, it should be stressed that several attempts at the problem will almost certainly be necessary before any acceptable solution can be expected.

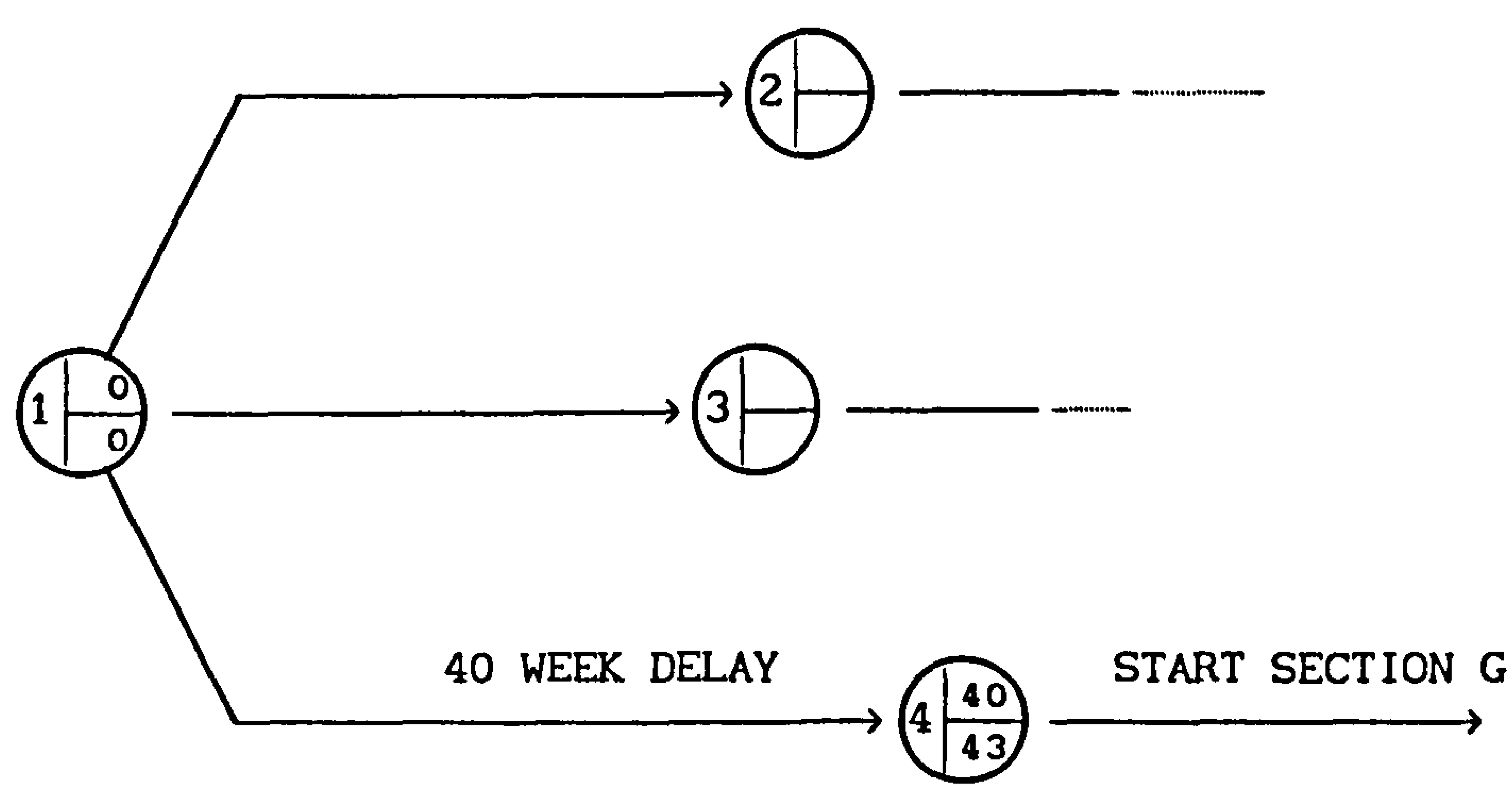
iii) Float in all its various guises seems a particularly difficult concept for many students to grasp. The problem is not so much accepting that non-critical activities have some flexibility in when they must be achieved, but in getting a physical 'feel' for the different types of float.

iv) An understanding of float and the fact that some float is not wholly owned by the activity it is associated with, is also the key to resource scheduling. Students may schedule activities within their total floats to achieve some objective with regard to resource utilisation. Unless the resulting schedule is checked against the basic logic network, however, it is possible for a totally unworkable solution to be recommended.

v) It is much easier when teaching CPM simply to talk about the planning stage, with an idealized view of the project as made up of known activities whose durations are well defined and unchanging. To some extent this view must prevail, at least when the mathematical operation of determining earliest and latest event times is being conducted. It is essential, however, to stress that this is an unreal view of any project. Provided it has been sensibly constructed, the plan produced will help to bring in the job on time and to a price. However, the uncertainties that have been incorporated or ignored must not be forgotten. An example of the need to recognize the problems associated with the real world arose in a hypothetical project tackled by the author's students. In this project, a section of the job (section G) was specified as not being able to start until 40 weeks after the main project start. The network produced clearly had to accommodate this condition. A common reaction to this problem was as follows. Having completed the rest of the plan excluding this section, and carried out the forward and backward pass, some students then found an event whose earliest event time was 40 weeks or just later and showed the delayed section of the job as starting from this node. This solution is shown diagrammatically in figure 10.1(a). Clearly such a network will work providing that when the job progresses, all activities take a time to be completed equal to their estimated durations, start at their earliest times and that nothing occurs that was not planned for.



a)



b)

Figure 10.1 Dealing with a delayed start to an activity

This is a most improbable outcome and certainly should not be the basis for a good plan. A better way to schedule this condition is demonstrated in figure 10.1(b) using a 40 week delay from the initial event to precede the beginning of this section.

The problems detailed above, together with a feeling that the available images of the project plan somehow failed to provide the best image, lead the author to develop a new model of the network. This new model will be described later, following discussion of the currently available methods of representing a project plan.

Standard images of the project plan

The need for a new image of the project plan that would clearly illustrate the inflexibility of critical activities and the restrained flexibility of non-critical ones has been introduced in the previous section. The currently available images will now be discussed. It must be made clear that the new model is not intended to supersede the existing images. Its aim is simply to complement them and perhaps to provide the final potent image to give the maximum 'feel' for the nature of the project plan. The actual network used in the figures in this chapter is taken from Pilcher, (51).

1. Logic network (figure 10.2)

The completed network diagram containing earliest and latest event times provides all the information necessary to define the project plan prior to resource scheduling. The ordering of activities can be easily seen and production of this diagram represents an important step in the understanding of the project. However, although the information is all there; that is the event times and activity durations are clearly detailed, the feel for the time element in a project is not well served by such a plan. The extent of the float of non-critical activities only becomes evident when calculations have been performed and such figures for a number of activities are not easily retained in the mind. Even if the various floats of each non-critical activity were to be listed against those activities, this would still not be particularly instructive.

2. Bar chart (figure 10.3)

Having completed the network analysis and produced the logic diagram just discussed, it is often seen as helpful then to draw a bar chart. This represents the results of the analysis in what is generally considered a more accessible format. Depending on whether a resource scheduling exercise has been carried out, the bars showing the scheduled dates for the activities will either be

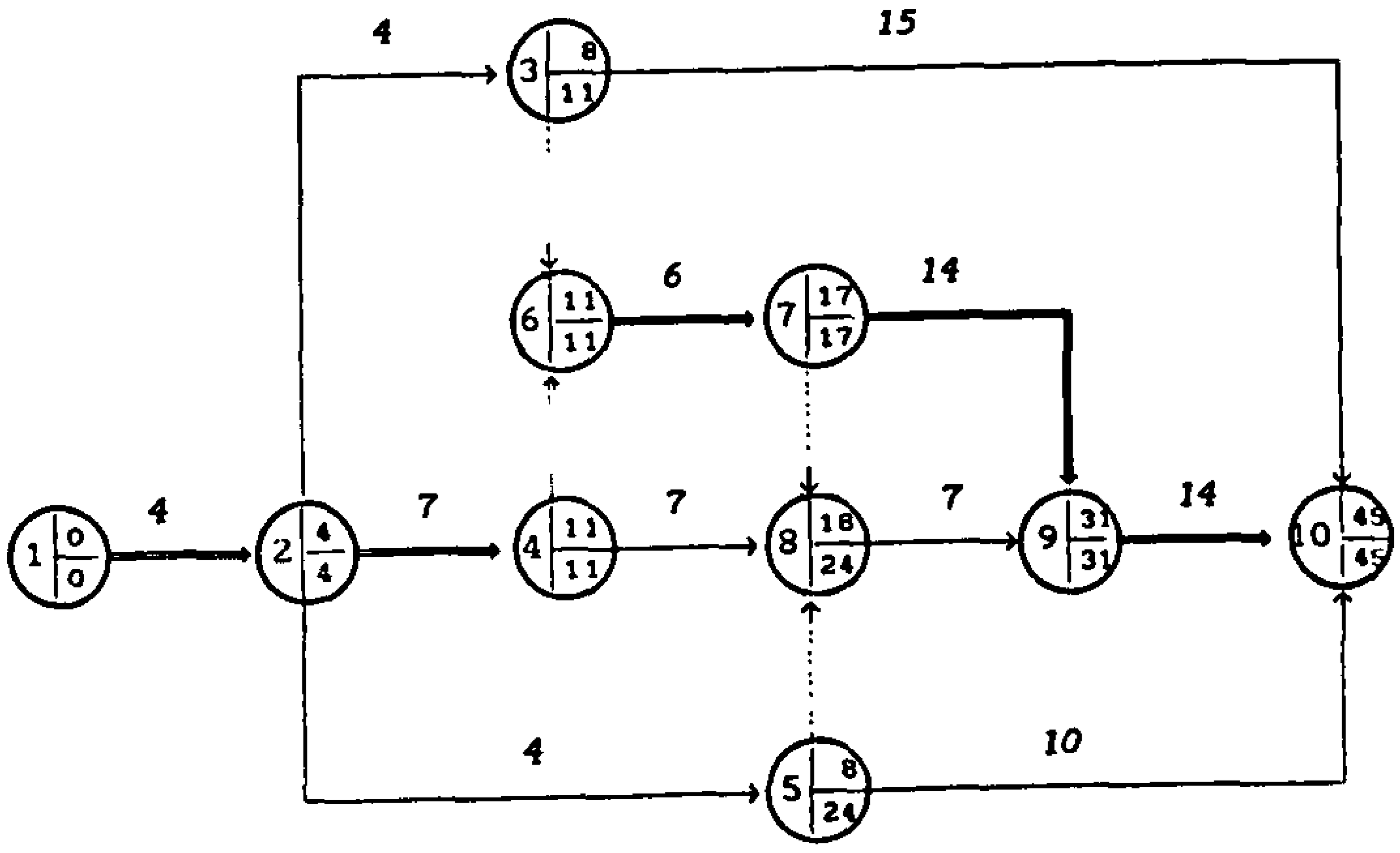


Figure 10.2 CPM network diagram

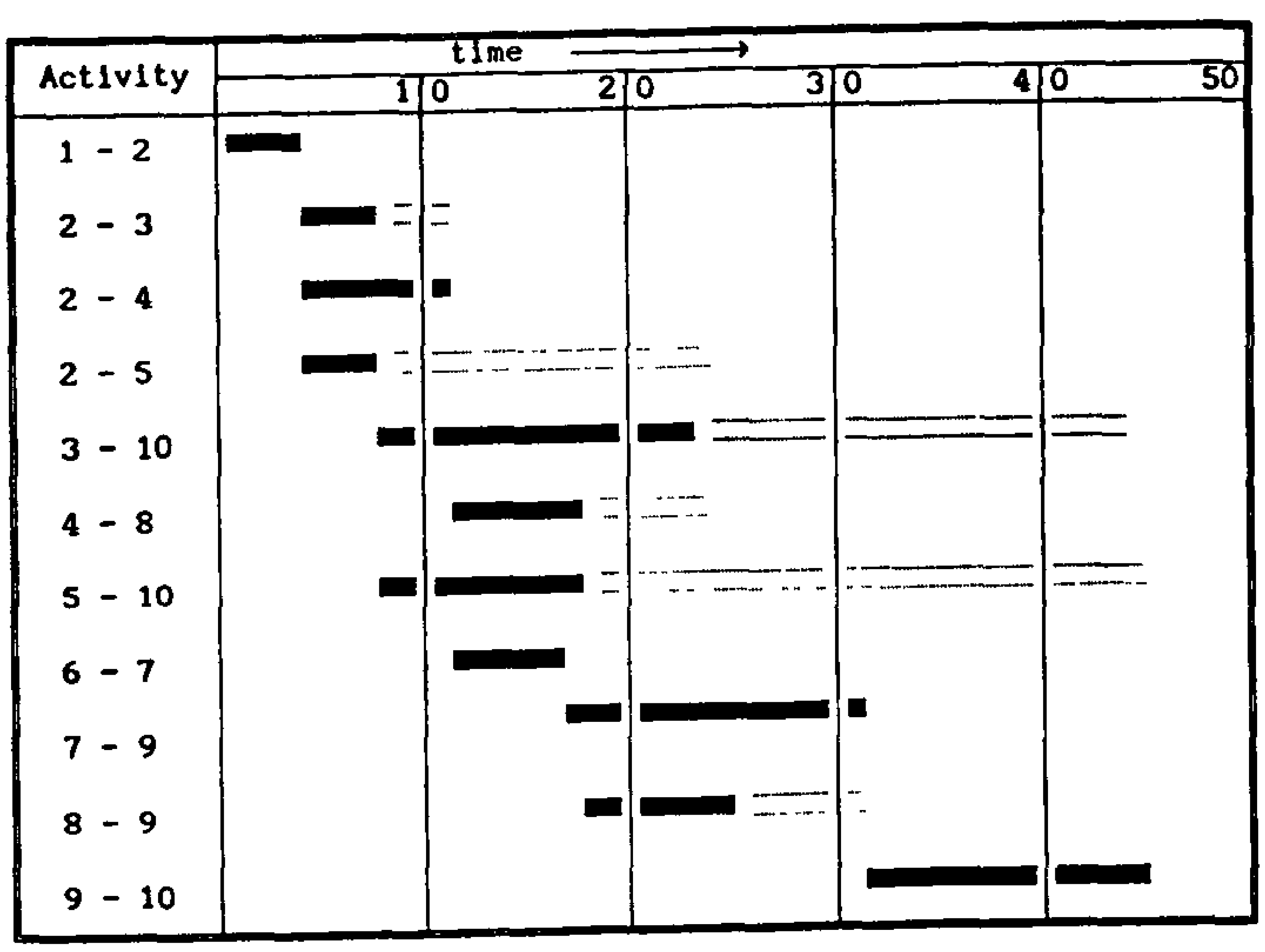


Figure 10.3 Bar chart

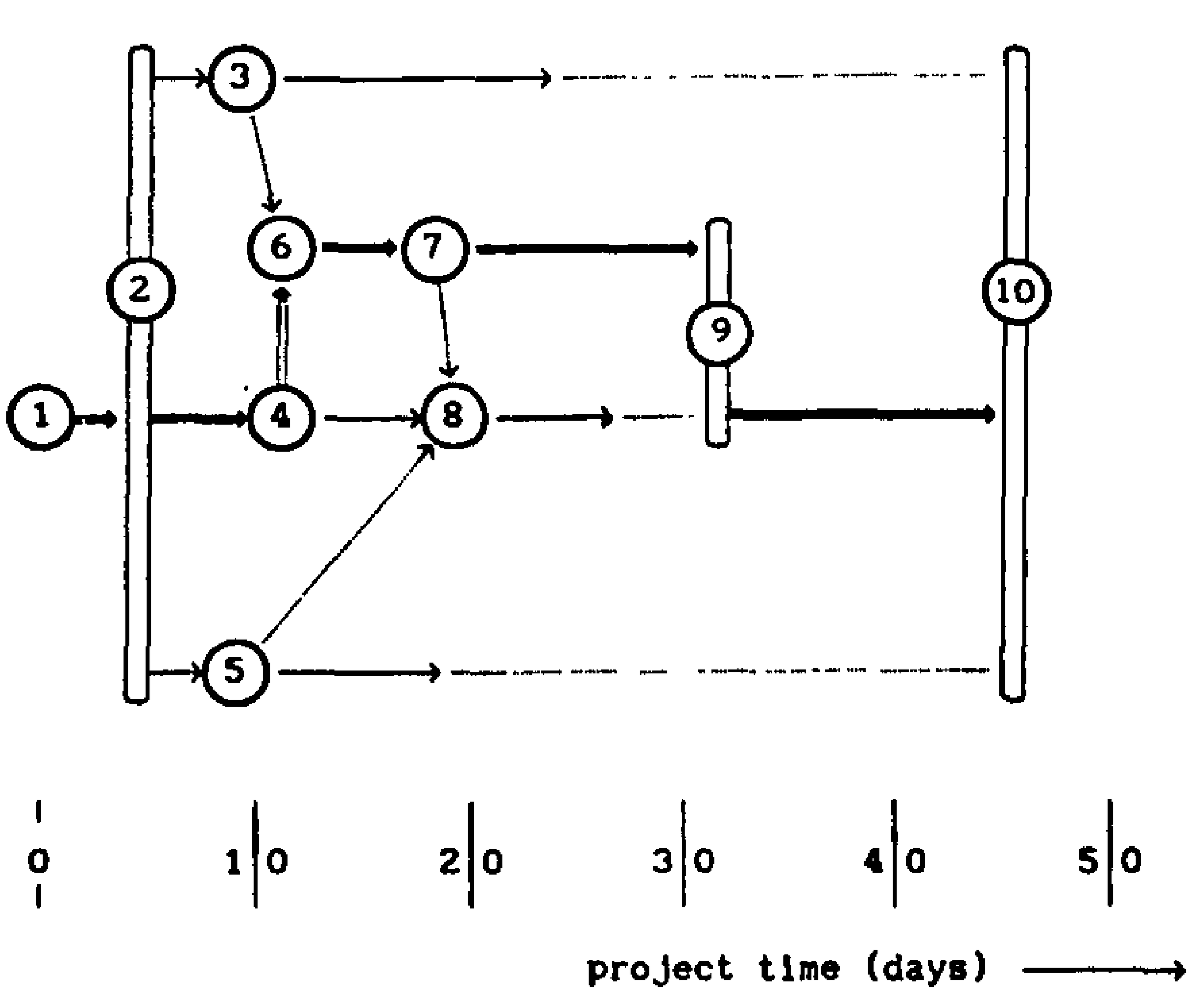


Figure 10.4 Time-scaled CPM diagram

totally fixed in time or will show the activities as taking place at their earliest start dates. Total float is typically shown by dotted lines. Figure 10.3 is a bar chart for a project where resource scheduling has not yet taken place. As recognized in the questionnaire survey, this format is often the one adopted to represent the construction process at the start of a contract. A recent book by Nahapiet & Nahapiet (52), detailing a study of 6 American and 4 British construction projects in the private sector, reported that of these 10 projects only 4 had used CPM during construction. The others relied solely on bar charts. For a project where resource scheduling has taken place, the resulting bar chart appears to show exactly how the work will proceed, in that the start and end dates of every activity are detailed on the diagram. If the work was to progress exactly as planned, with no delays or adjustments due to additional work or weather effects, such a plan would be perfectly adequate. However, because in the construction field this is probably the one outcome we can be sure will not occur, changes must be accommodated. As the bar chart gives no indication how such changes would affect the overall project, by itself it cannot deal with the situation. Clearly such adjustments may be made using the previous logic diagram and then the revised results again displayed in bar chart form. The point being made is that the bar chart used alone cannot predict the necessary changes. The bar chart is thus an ideal format for illustrating the time dimension of our plan but gives no help with understanding the inter-relationships between activities.

3. Time-scaled CPM diagram (figure 10.4)

The two previous diagrams used to illustrate the project plan have failings when considered as a complete representation of the project. The logic network does not easily show the time element of the plan and the bar chart cannot deal with the logic. There are, however, two other available images that attempt to show both these aspects of the plan: the linked bar chart and the time-scaled CPM diagram. The relative merits of these two techniques may be studied in the paper by Melin and Whiteaker (53), who describe a particular type of linked bar chart and the subsequent discussion by Lee (54), which details the advantages of the time-scaled CPM. The image preferred in this context is the time-scaled CPM diagram, in which preceeding and succeeding activities on a path through the network are shown in the same horizontal line. It is easy with such a plan to see how changes to one activity will have knock-on effects on succeeding activities. This is typically the image most frequently used when extension of time or acceleration claims are to be contested in American court proceedings (Wickwire and Smith (25)). There the clarity of the arguments and diagrams used to support those arguments is paramount. However, as good as this image is, it is considered that an improvement is still possible for the teaching environment. The non-critical activities in such a diagram must be represented at some scheduled date (usually early start). Although a certain impression of available float is given by the dotted line at the end of a non-critical path, the different types of float and the interaction of activities within a non-critical path are not easily shown. By constructing a 'hard' model of such a network, in which the various activities with float can actually move as defined by the logic, it is believed that the most telling image of the project plan can be achieved.

The new model

1. First design

The first design of the new model is illustrated in the photograph in figure 10.5, in which all activities are shown at their earliest start dates. It is quite clearly a time-scaled CPM diagram as shown in figure 10.4, but with the added facility that all activities can be moved on the board within the restrictions of the network logic. This is achieved, rather crudely with this prototype, by using taut lengths of string on non-critical paths to which the time-scaled activities are attached. They are threaded on the string in the order in which they must be carried out, and are able to move along it. Thus, for example, activity 2-5 cannot physically follow activity 5-10 because of the order in which they have been threaded onto the string.

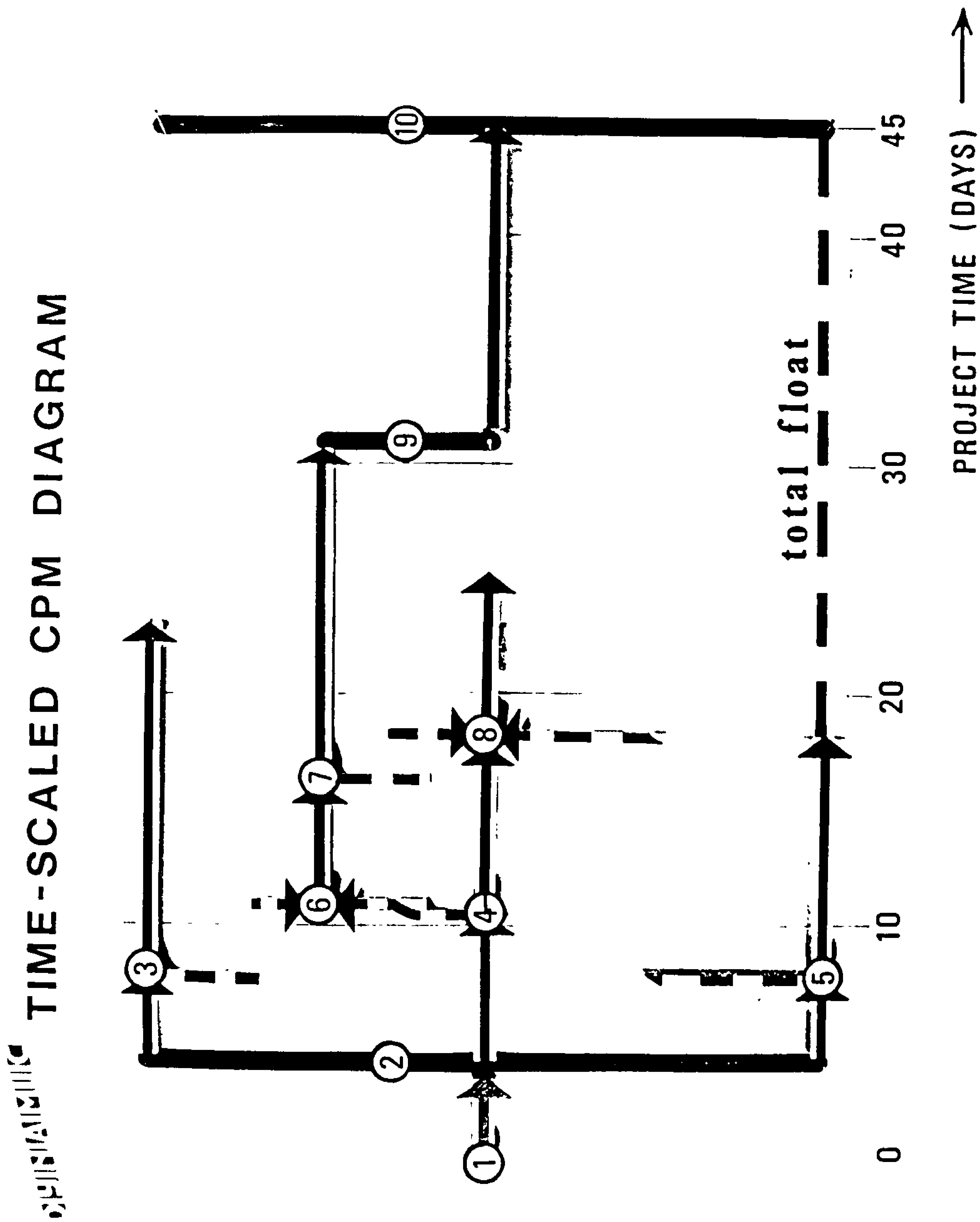


Figure 10.5 The new model - first design

Both activities may, however, move along the string in this restrained fashion.

Some mechanical means of representing the dummy activities crossing between adjacent paths in the network had to be found and this was managed by splitting the dummy activity into two parts. The tail of the dummy was attached to the earlier activity and the head of the dummy to the later activity. An example of this can be seen in dummy activity 5-8 where the completion of activity 2-5 cannot physically be delayed beyond the start of activity 8-9 as a result of the two overlapping parts of dummy activity 5-8. On this model, the critical activities cannot move at all, having been nailed to the board. Explaining this to the students during lectures gets across a feel for the basic inflexibility of these activities. Similarly, the fact that non-critical activities may be slid along their strings helps the understanding that there are still choices to be made regarding when these activities can be carried out.

2. Second design

As previously stated, the first design was very crude and a number of improvements were considered possible. Figure 10.6 shows the latest development of the model. All activities are in their proper place but no attempt has been made to demonstrate minimum project time. Instead of

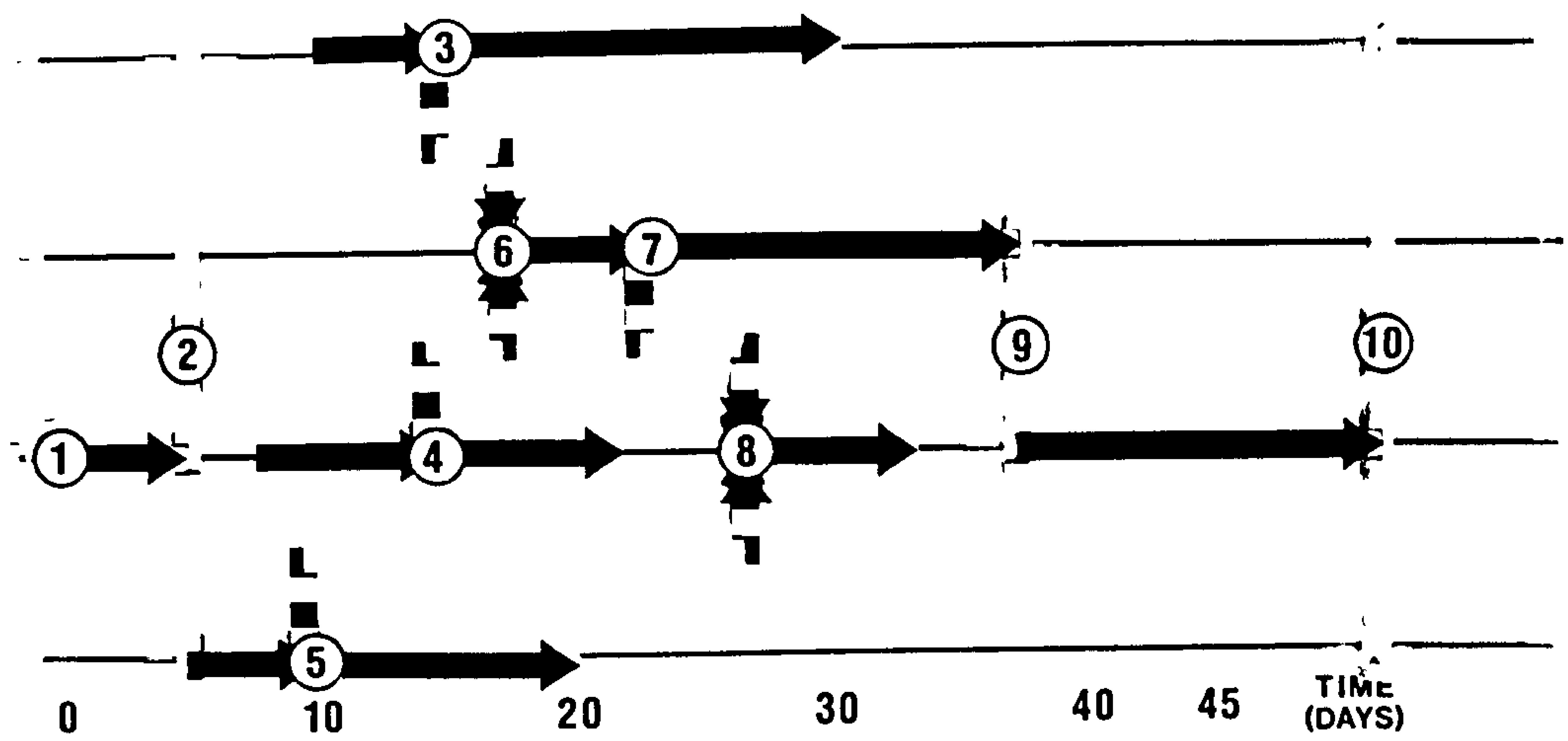


Figure 10.6 The new model - second design

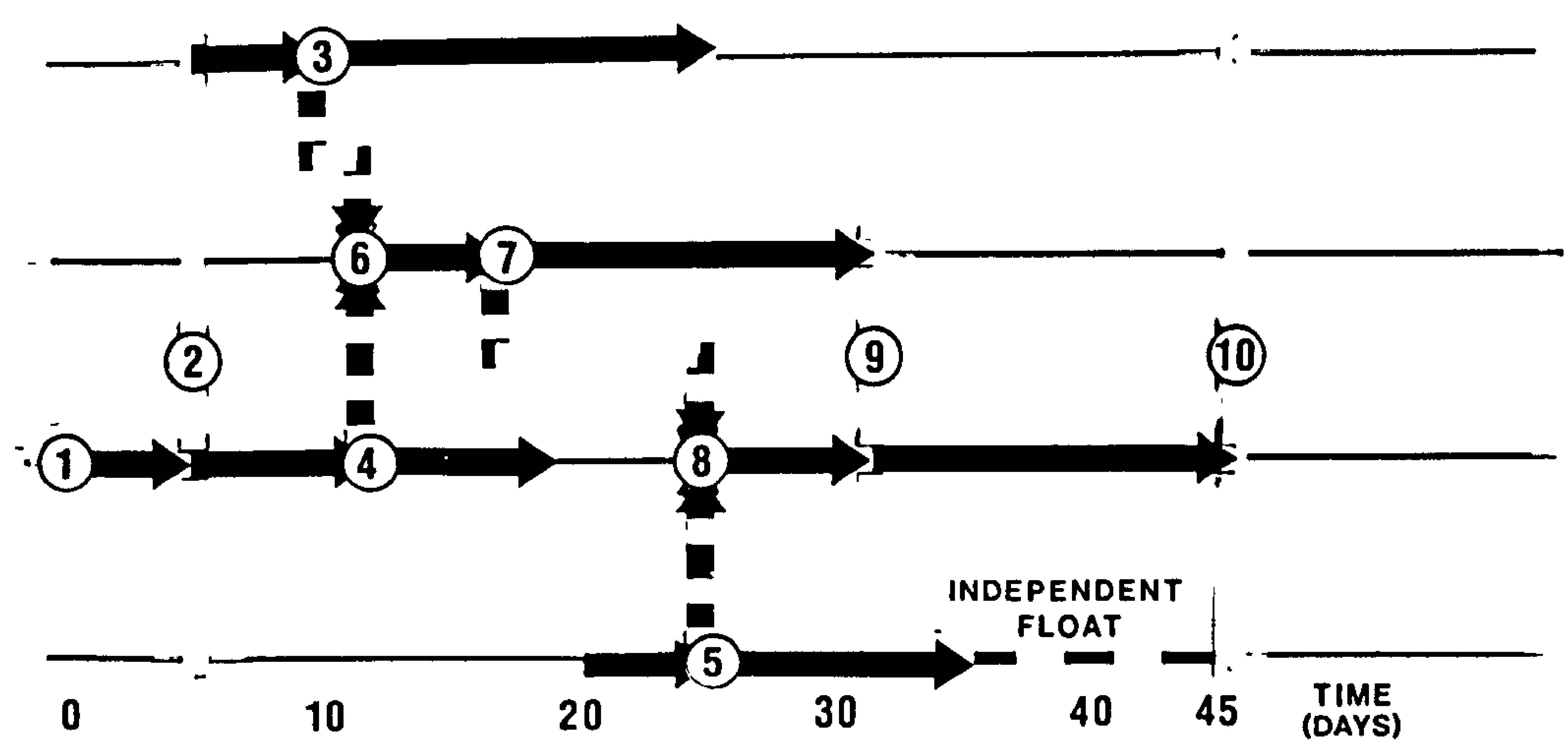


Figure 10.8 The new model demonstrating independent float

using string to mount the activities on the board, a board with a number of parallel horizontal slots into which the activities have been fixed permits the same kind of movement of activities. This can now take place without the sag that inevitably occurred when the board on which the first model was fixed was held vertical. With the previous model, the extended events 2,9 & 10 were unable to move, having been drawn on the backing paper. However, in this model, making all events from solid pieces that can move within the slots on the board allows additional benefits to be achieved, as follows:

i) Once having produced the 'hard' time-scaled activities, these can be mounted individually in the slots on the board and the network built up in this way. The requisite 'hard' events both circular (as event 1) and extended (as event 2) can be added when necessary.

ii) Having located all the activities and events on the board, if the first event is then pushed toward the last event until no further movement can take place, then the path(s) through the network causing that resistance is/are, by definition, the critical path(s). It is believed that such a demonstration is particularly helpful in creating the right impression of the critical path network. It shows that a critical path is only critical if we insist on completing the project in the minimum time.

Professed advantages of the new models

i) Visual impact: the main advantage claimed for this form of presentation is its visual impact. When CPM must be taught in a limited time to students who have a number of other subjects to deal with, perhaps the best any lecturer can do is to make sure that the most useful and potent images are presented. The hope is that these at least may linger in the memory. The model offered, it is believed, provides such an image going beyond the potential of the normal time-scaled CPM diagram. This is achieved by reflecting the flexibility of non-critical activities and the inflexibility of critical activities in what is considered to be a most meaningful way.

ii) Illustration of float: as previously stated, students often have difficulty in grasping the significance and nature of the various types of float. Although the diagram often used to explain this phenomenon (figure 10.7) is certainly helpful, it is limited in what it can show:

a) For clarity, independent float is usually drawn as having a positive value in this diagram and this becomes the student's expectation. When the student analyzes a network and finds an activity with negative independent float, a situation that can arise whenever there are more than two activities on a non-critical path, the student's confidence in his understanding is diminished. The

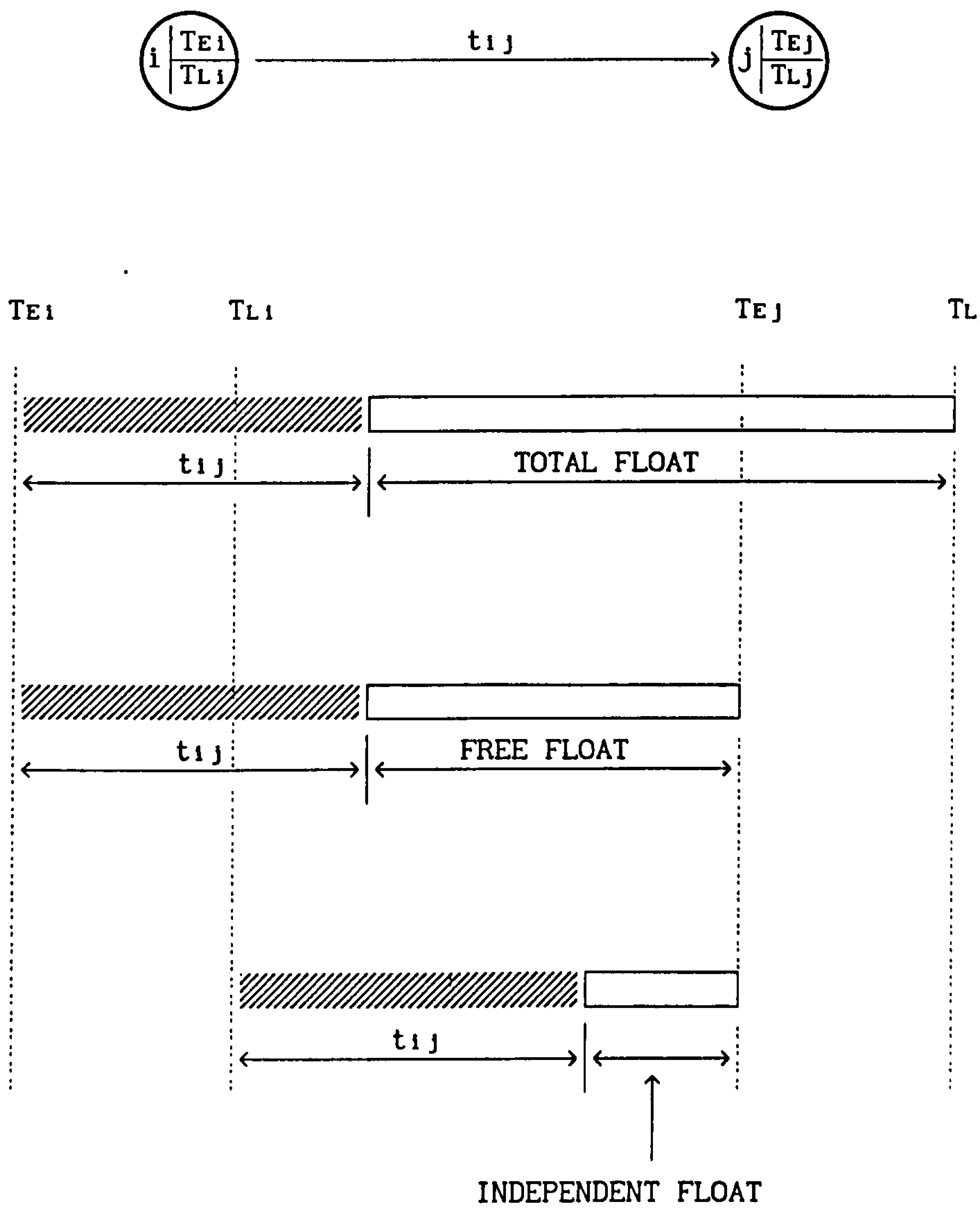


Figure 10.7 Diagram to explain the various types of float

diagram thus shows just one of the possibilities, and unless this is understood, can be misleading as a result.

b) Of necessity, the diagram is removed from the original network and only represents a small part of it. That is it only deals with one activity. Armed with this understanding of the nature of the various floats, it requires considerable insight to relate this to the much more complex situation pertaining in the network as a whole. Probably more than is usually available. If instead of using this diagram we now use the new model to illustrate the different types of float, it is possible to select any of the activities and to demonstrate all the various forms. Thus, as an example, the independent float of activity 5-10 is being demonstrated in the picture shown in figure 10.8. To determine the independant float, which is the float wholly owned by the activity in question and not available to any other activity, we must position all preceeding activities, in this case activity 2-5, as late as possible and succeeding activities, of which there are none, as early as possible. This is the situation shown in figure 10.8. Thus, the student can perform calculations to work out the float of any activity and by 'playing' with the model see his results represented in a much more meaningful form.

iii) Illustrating network review - the process of reviewing networks part way through the construction process is often difficult for students to grasp. By using the new model, it is felt that this difficulty may be alleviated. The necessary procedure is as follows:

a) Stretch a string across the board to represent 'time now' (say at 25 days).

b) All completed activities will lie to the left of the string. All activities yet to be carried out will lie to the right of the string. Activities which are underway at the time of the review should be positioned such that their outstanding durations lie to the right of the string. The critical path and time to completion can then be determined.

In undergraduate courses that are becoming ever more crowded with increasing amounts of apparently essential information, the time available to study any particular aspect of the course is likely to be limited. This means that the maximum impact must be made in the time available if the student is to gain a real understanding. It is thought that models such as the one described here can provide the means to make such an impact, leaving the most useful impression in the student's mind.

CHAPTER 11

THE MAIN FINDINGS

Because of the somewhat unusual structure of this thesis, it was considered helpful to provide a final chapter in which the principal strands of the work are brought together. These are the main findings which have resulted from this research and can be best represented in the following categories:

A Dealing with concurrent delays

B Use of contract programmes

C Record-keeping on construction sites

D Teaching of CPM

A Dealing with concurrent delays

In chapter 3, a number of methods of analysing so-called 'concurrent delays' were identified and discussed. From this review, a number of suggestions have been made. These are as follows:

i) Concurrent delays on parallel critical paths should be dealt with using the adjusted CPM approach, and it is only where two concurrent delays both affect one activity that any ruling may be needed. A definition of concurrent delays might thus be: concurrent delays are two or more delays that both occur at the same time and that affect an individual activity. Where this occurs, whether on a critical path or not, it will be important that this overlapping delay situation is resolved to a series of delays to allow the adjusted CPM schedule to be identified.

ii) The concept of parallel critical paths appears to have no sensible meaning when as-built programmes are to be dealt with.

iii) Some delays might have had their effect at times other than those when they were actually effective, for instance, additional work delays. It may be helpful to be aware of such matters when considering concurrent delay situations.

iv) A method is offered which will allow the exceptional adverse weather days to be uniquely, although arbitrarily, defined.

B Use of Contract Programmes

One of the prime objectives of the research was to identify how contractors and supervising engineers are actually using the contract programmes for their contracts. From this understanding, together with the knowledge gained from the literature, a number of recommendations have been made. The principal conclusions and recommendations in this area will now be considered:

Conclusions

These are recorded in full in chapter 6, and only the principal conclusions will be reported here.

i) There appears to be no consensus amongst Engineers concerning whether to specify the format which the contractor is to adopt for the contract programme. Some define the format, while others rely on clause 14. When no format is specified, Contractors prefer to use a format which typically will not reveal their assumed logic.

ii) Extension of time claims were found to occur on 60 - 70% of all civil engineering contracts.

iii) The methods accepted for making and assessing delay claims in the U.K. appear not to be well defined. There is some evidence to suggest that U.K. engineers and contractors will identify such claims simply on the basis of the delays on an identified critical path. This is contrary to the U.S. approach of looking at the whole as-built network for the contract.

xiii) The gap which exists between the approaches adopted for dealing with delay claims in the U.K. and the U.S.A. has been recognized and one possible explanation for this anomaly put forward. It is suggested that the method of resolving delay claims in the U.S.A. which will typically produce a ruling that can be quoted as a precedent may have been the prime cause of developments in this area of the law. Such precedents are not usually set in the U.K., where rulings are less likely to be made public.

Recommendations

A number of recommendations have been made and these are reported in detail in chapter 6. The principal recommendations are as follows:

i) Contractors should be required to use CPM to plan all but the simplest of projects, but the contractor should be allowed to use any reasonable format to represent the results of his plan. A listing of his assumed network should also be provided so that the engineer will be able to recognize the contractor's proposed logic.

ii) In order to check a contractor's programme properly, it is envisaged that a period of intense study will be needed. A detailed check list has been compiled to assist this process.

iii) In assessing delay claims, perhaps the most difficult of all situations is one in which an extension of time must be considered part way through the contract. The thesis recommends an approach which will provide up to date information on the effects of delay as each event in the network is reached. This should provide the most useful information for dealing with such a claim.

B Record-keeping on construction sites

Having once recognized that the initial plan for a project will soon be overtaken by events, the need to address the problem of record-keeping soon becomes evident. In order to make use of the plan, it must be updated, and this means that records of actual progress must be used. In the area of delay claim assessment, this will preferably mean that a detailed record of exactly when the individual activities of the project were carried out should be available. The second part of the thesis addresses record-keeping specifically and the main findings, reported in chapter 8, were as follows:

i) The personal records of the Engineers and Contractors interviewed were typically kept in bound page-a-day diaries. Inspectors working for the R.E. would often use either standard record sheets or a loose leaf diary.

ii) It was common also to keep a weekly or monthly record of progress. This would sometimes report percentage completion of the activities. It was not clear whether this was generally kept for all activities or just for the major ones.

iii) Concerning the content of personal diaries, some organizations gave advice about what should be recorded, while some others said that they monitored what was being recorded and reacted to bad practice. None of the organizations interviewed made recommendations regarding how the record should be laid out.

iv) In general, Engineers were more satisfied with the quality of their records than were Contractors.

The following recommendations, reported in chapters 8 and 9, were made:

i) Any quality assurance scheme adopted by Contractors or Engineers should also cover the process of keeping records during construction. This applies particularly to Engineers, and their clients should be demanding such an inclusion.

ii) A daily record should be made of each activity on which work is being carried out. This should also record when delays are effective and would be best kept on a computer, using a program such as RECORD-KEEPER. This record should be kept alongside existing record-keeping systems and should function as an index to these other records as well as providing essential information for assessment of delay claims.

C Teaching of CPM

A new model for representing the CPM network has been developed which is believed to have advantages over the currently available models. By allowing activities to move on the model within the restraints of the network logic, it is felt that the clearest understanding of the essential CPM approach can be obtained. This new development stemmed from the author's interest in the current research area coupled with a wish to teach CPM effectively.

APPENDIX 1

CORRESPONDENCE WITH CO-OPERATING ORGANIZATIONS

CORRESPONDENCE WITH CO-OPERATING ORGANIZATIONS

INITIAL LETTER SENT TO CONSULTANTS ON 3RD & 4TH MAY 1989. SIMILAR LETTERS WERE SENT TO CONTRACTORS AND LOCAL AUTHORITIES

4th May 1989

Dear Sirs,

RESEARCH PROJECT INTO THE USE OF PROJECT PLANS DURING CONSTRUCTION

A good deal has already been written about the use of project plans to monitor and control the progress of construction, but there is little information available to guide the engineer in the use of such plans to validate claims for extensions of time and acceleration, or to justify the deduction of liquidated damages. It is in this area that the current research is focussed and in particular, it is intended to investigate the following by means of interviews based on a questionnaire:

i) What format is generally adopted for the clause 14 (ICE 5th edition) programme, and how is the programme checked by the Resident Engineer/Engineer ?

ii) What general procedures are currently used for validating claims for extensions of time and acceleration ?

iii) How are records kept on construction sites and should these be modified to assist in the assessment of claims ?

The questionnaire was prepared last year and was tested by conducting a few sample interviews in a pilot study during the summer of 1988, prior to carrying out the full survey this year. The main aim of this research is to determine attitudes held and procedures currently adopted in this area in order that the present state of the art may be determined. By studying how these claims are dealt with at the moment and identifying any specific problem areas, it is hoped to be able to offer helpful guidelines which will define good practice in the handling of such claims for the future. In particular, the methods adopted in the UK will be compared to those currently in use in the USA to see if anything can be learnt from the American experience.

It will no doubt be clear by now that my purpose in writing to you is to enlist your help in carrying out these interviews. Indeed, what I am asking for specifically is an opportunity to interview two members of your staff - an engineer working as a Resident Engineer and one working as a Nominated Engineer - both involved in contracts governed by the 5th edition of the Conditions of Contracts. I estimate that each interview will take approximately one and a half hours and am happy to travel to any reasonably close location to carry them out.

It is hoped that the research will eventually lead to material which will be published either in conference proceedings or in technical journals but no mention will be made of the particular organisations involved and all information received will be treated in the strictest confidence.

I would be most grateful if you could assist me in this project and will be happy to answer any queries you may have.

Yours faithfully

S.Scott (Lecturer in Construction Management)

REMINDER LETTER SENT TO 9 CONSULTANTS WHO HAD NOT RESPONDED BY 24.08.89. SIMILAR REMINDERS WERE SENT TO CONTRACTORS AND LOCAL AUTHORITIES.

24.08.89

Dear Sirs,

RESEARCH PROJECT INTO THE USE OF PROJECT PLANS DURING CONSTRUCTION

I wrote to you on the 4th May to ask if you would be willing to allow me to interview members of your staff in connection with the above but have not, as yet, received a reply. It is quite possible that my letter may have been lost in the post and so I am enclosing a copy and repeating the request for assistance. Interviews have already been successfully completed with five consultants and I would wish, if at all possible, to complete all interviews during 1989.

I should be most grateful if you could help me and look forward to an early reply.

Yours sincerely,

S.Scott
Lecturer in Construction Management

APPENDIX 2

RESPONSES TO ENGINEER'S QUESTIONNAIRE

RESPONSES TO ENGINEER'S QUESTIONNAIRE

Engineer's version No 6 (final questionnaire 22/9/89)

This questionnaire relates to contracts for civil engineering works which will typically adopt ICE Conditions of Contract, 5th edition.

CONTRACT PROGRAMME DETAILS

Q1 Do you ever specify the format of the Contractor's (clause 14) programme?

	R.E.	NOM ENG
YES	*3 (4,5,9)*	*3 (3,8)*
NO Go to Q6	*1 (11)*	*4 (1,2,6,7,10)*

Q2 In what situations do you specify the programme format?

* *On major projects (> 5mill) (3)*

* *All the time (4)*

* *Most (5)*

* *Usually depends on the person producing the documentation. Clauses used properly on one scheme may be misused on others (8)*

* *All (9)*

* *Have specified in the past, but generally contractor allowed to choose (10)*

Q3 How frequently do you specify the programme format?

* *On major projects (>5mill) (3)*

* *All the time (4)*

* *Most jobs of substance (5)*

* *Always (8)*

* *Always (9)*

* *See above (10)*

Q4 What format(s) is/are specified?

* *CPM (3)*

* *Network-based (4)*

* *Critical path network with bar chart summary (5)*

* *Bar chart based on CPM (don't ask to see network). Sometimes separate structures programme. Show critical path (8)*

* *As new brown Spec. (9)*

Q5 Are any standard specification clauses or standard amendments to clause 14 adopted for this purpose?

* *Specification clause (3,4,5)*

* *Specification clause proforma - adjusted for each scheme (8)*

* *New Brown Spec (9)*

* *Nothing (10)*

Q6 Why do you operate this policy?

NO

* *Contractor should be happy with format (1)*

* *Never found it necessary - civils not so complex (2)*

* *Get understandable programme in this way (6)*

* *Don't want to impose on the contractor (7)*

* *Don't want to restrict the contractor (11)*

YES

* *Most have tight time scale - want to identify early what the problems are (3)*

* *Don't know. (4)*

* *Ensure that the contractor has looked at the job and made a thorough and good assessment of what he has to do. Can be useful to determine our design programme (if any) (5)*

* *Clause 14 totally inadequate - doesn't ask for durations/resources/working hours/criticality of events (with a view to monitoring progress wrt E of T later) (8)*

* *Tradition/DTp (9)*

* *Best to allow contractor to use the technique he prefers (10)*

* *Don't want to restrict the contractor (11)*

Q7 Who checks the contract programme?

* *R.E. and project engineer (design) (1)*

* *Initially R.E., then discussed with Nominated Engineer (2)*

* *Project partner has first look - checks in outline and passes to project engineer and R.E. (3)*

* *R.E. (4)*

* *R.E. - high level of responsibility given to site staff (5)*

* *The Engineer (Engineer has lived with job, R.E. steps in) (6)*

* *Project Engineer (not R.E.) (7)*

* *RE looks at detail; claims manager then has meeting with RE (8)*

* *RE does detailed analysis then passed onto deputy C.Eng (9) (10)*

* *Main check by RE; overlooked by Nom Eng (11)*

Q8 How is this check carried out?

* *Check targets in contract; check durations of key items (looking for unrealistic durations) (1)*

* *Logical progression through the job; check durations are sensible; check against dates in contract; often ask for plant resources. (2)*

* *Ensure fits in required time scale; complex areas checked individually (durations); check other time requirements on program (staged?). (3)*

* *Assess durations; superficial check on order of activities; check specific restrictions. (4)*

* *Make sure major tasks are identified and that logic is sound; subsidiary check of durations (contractor's judgement). (5)*

* *Check tie-in with time for completion; check if durations are realistic; check sequence - are overlaps realistic?; what has been done with float?; activity size reasonable? (6)*

* *Check compliance with completion date; are durations reasonable? (7)*

* *Checklist used: information asked for included?; all activities included?; Public Utilities in particular; trafficking/possessions?; productivity rates?; holidays allowed for? - common sense things. (8)*

* *Feasible logic; sensible outputs/rates; (have a feel for output figures); check with contract requirements; other contractors/ P.U.'s (9)*

* *Check logic; check for sensible durations - meeting to discuss programme (10)*

* *Fits within contract parameters; check logicality; check estimates of durations (11)*

Q9 How important do you consider this check to be?

VERY IMPORTANT

* *Insist on revision where necessary (1)*

* *Vital (2) (8)*

* *Do a thorough job (3)*

* *Possibility of come-back later if not properly checked initially (9)*

* *One of the most important documents (10)*

* *Importance depends on the client's requirements - programmes are never unimportant (11)*

FAIRLY IMPORTANT

* *At the end of the day the programme is the contractor's responsibility (4)*

* *Responsibility is contractor's - not up to the R.E. to tell him how to do it (5)*

* *Usually lots of other things to do at the same time (6)*

* *Tender programmes requested and presumed to be the basis of the clause 14 programme (7)*

Q10 It can be very difficult to represent the expected progress of a complex project in a relatively few activities - in checking the contract programme, do you consider it necessary to point out all the ways in which the contract programme fails to properly portray the construction process (however niggling)?

* *Point out all matters on which we are uneasy (1)*

* *Always clarify (2)*

* *Yes (3,4,7,8,9,11)*

* *No - looking at the broad sweep (5)*

* *If money likely to be involved, more likely to comment. Not necessarily every failure. (6)*

* *Not concerned about minor aspects (10)*

Q11 Do Contractors ever include activities in their programmes which are to be carried out by the Engineer?

* *Yes (1,3,11)*

* *Full details usually available at tender therefore doesn't happen (2)*

* *No (4,5,9)*

* *Not usually - one instance experienced (6)*

* *Times at which information required (7)*

* *Rare - in minor way (8)*

* *Not aware (10)*

Q12 If so, and if these are accepted, are they then considered to be binding?

* *Not consider this contractually binding (1)*

* *Would be bound by it (2)*

* *Yes (3,7)*

* *-- (4,6)*

* *Would consider this binding (5)*

* *Not legally binding but a fair indication that this was reasonable (8)*

Q13 Is float ever shown in contract programmes?

* *Yes (1,2,4,5,7,8,11)*

* *No (3)*

* *Yes, not always (6)*

* *Occasionally (9)*

* *Rare (10)*

Q14 Are contract programmes usually presented in the format/detail you would wish?

* *Yes (1)*

* *Format OK, detail often lacking (2)*

* *No (3,9,11)*

* *Basically yes (small contracts) (4)*

* *Yes (5,10)*

* *Generally OK (6)*

* *No - depends on the contractor (7)*

* *This should be specified (8)*

Q15 If not, what are the common failings?

* *None (1)*

* *Lack of detail in block items; lack of interconnection (2)*

* *Far too little detail; broad brush when clearly not sufficient; sometimes not aware of critical dates in the contract (3)*

* *One activity representing a number of smaller activities, i.e., all lumped into one on the programme (4)*

* *Introduction of CPM has lead to failings being reduced (5)*

* *Scruffy handwriting; mysterious dotted lines (6)*

* *Activities combined into one. Bill sections become activities (7)*

* *If left to the contractor - not as you would wish - lacking detail (tie-ins) - always get satisfactory overview (8)*

* *Insufficient detail - sometimes don't appear too professional (9)*

* *Insufficient detail - does not fully display logic; basic errors and misunderstanding (11)*

Q15A Do you ask for information on the Contractor's resources, and if so, at what stage is this requested?

* *At tender stage (incl resource programme) (1)*

* *Usually ask for this with Cl. 14 programme (2)*

* *Yes, for certain aspects of the job - often asked for at tender (3)*

* *Yes - included in Spec clause (4)*

* *On occasion - particularly labour and maybe plant (large job). Cash flow also requested (5)*

* *Yes, method statement with tender to include plant resources (6)*

* *No (7)*

* *Yes, along with Cl 14 programme. Spec clause defines 'reasonable information' as requiring that (8)*

9,10 & 11 don't contain this question

Q16 What format tends to be adopted when none is specifically specified?

* *Bar chart (1,3,4,8,9,11)*

* *Bar chart (sometimes linked bar chart) (2)*

* *Bar chart (simpler jobs) (5)*

* *Usually A3 sheet bar chart, sometimes linked (6)*

* *90% are bar charts (7)*

* *Time-location and bar chart (10)*

Q17 How do you respond to the contract programme?

* *Respond formally, agree with it or reject with comments. Key items - request method statement (1)*

* *Rarely write back and approve - more likely to respond that it is not acceptable (don't usually go into writing). Demand a revised programme (2)*

* *Acknowledge receipt. Meet with Agent to see what he has to say about the programme - minuted. Write and point out failings (3)*

* *Formal acceptance if acceptable. If revisions requested it can be that they are never made, therefore no acceptance can be forthcoming (4)*

* *Write to say have received programme, would like to avoid saying that it has been approved (but often can't) - assume he will provide necessary plant and resources to achieve (5)*

* *First meeting after contract awarded - minuted acceptance or adjustments to be made (6)*

* *Letter including comments - tends to be no official approval (7)*

* *RE acknowledges + if acceptable, accept at first progress meeting. Usually not so simple - meetings take place with a view to approval at next progress meeting. Where possible accept but often with provisos (optimistic) (8)*

* *Write to accept, subject to resources (9)*

* *Write to accept (at end of day) providing adequate resources provided (10)*

* *Meeting with contractor to explain reservations and assumptions (explained by contractor). Inevitably changes required. Write to accept revised programme. If completely in error - simply say so ! (11)*

Q17A Please indicate your views on the importance of the following uses of the contract programme by ranking them in order, viz, 1 = most important, 3 = least important.

	ranking
* Use as the agreed plan against which the effects of delays to the project may be determined.	3 *(1,5)* 2 *(2,3,4,7,11) (6 - job with problems)* 1 *(8)*
* Use to define the agreed method of working and the order in which activities are to be carried out.	3 *(2,3,4,7,8,11)* 2 *(5) (6 - no delay problems)* 1 *(1)*
* Use as a control tool against which actual progress may be compared and future action decided.	3 *( )* 2 *(1,8)* 1 *(2,3,4,5,6,7,11)*

COMMENTS

* *All relevant and all used on each contract. Order may be revised on some jobs (1)*

* *Would like to answer all as 1 (2)*

9 & 10 don't contain this question

Q18 Do you believe that the contract programme is presented more with the intention of supporting future claims than as an attempt to actually predict how the contract will proceed?

strongly believe			don't believe	
5	4	3	2	1

COMMENTS

* *Depends on the contractor - just a few 5, most 1 (1)*

* *If you didn't ask for a programme you wouldn't get one - 30%:4, general:2 (2)*

* *Most:2 (3)*

* *5 (4)*

* *Depends on the contractor; there is an element of claimsmanship, for industry in general:2 (5)*

* *Depends on the contractor, some:5, some 1 (6)*

* *Depends on the contractor. Some do have the intention of supporting future claims, others don't (7)*

* *3 1/2 Often have little to do with what is actually to be done. Uppermost in the contractor's mind is that it will be used in a delay situation (8)*

* *3 (9)*

* *1 Tendency to make all activities critical (10)*

* *2 (11)*

Q19 What use is made of the contract programme during and following the construction process?

* *Monitor progress during; delay claims after (if job finishes on time, never used); feedback to design office (1)*

* *In constant use - at least once a month for monitoring progress. After the job for claims busting (2)*

* *Monitoring progress - main use; analysis of claims; analysis of contractor's performance (possible) (3)*

* *Monitor progress (4)*

* *Progress measurement; claims analysis - programme is a subsidiary guide - logic/time re-examined (5)*

* *Monitoring progress - assess on monthly basis; claims assessment; advising third parties (6)*

* *Monitor the works - point out when the contractor fails to comply. Can be used to determine cash flow (7)*

* *Programme used as basis of weekly reports - internal monitoring of progress + for progress meetings - contractor's assessment provided there. Cash flow analysis for employers (8)*

* *Monitor progress - update on monthly basis (9)*

* *Monthly monitoring (or weekly) of progress; use for assessing extensions and claims (10)*

* *Main during construction - to monitor progress; after construction - for assessing claims. Use original programme as long as possible until impossible - then ask for review (11)*

EXTENSION OF TIME/ACCELERATION CLAIMS

Q20 Six months into the contract, it is clear that the Employer has delayed a part of the Works in such a way that the whole of the contract will be delayed by 2 months. The time for completion is 24 months and the Contractor's original programme showed completion in 20 months. What should the Contractor do?

* *Carry on with construction; formally request an extension of time (1)*

* *Ask for an extension of time for 2 months (2)*

* *Claim for extension of time (only 6 months into job - more may happen) (3)*

* *Claim for extension of time (4)*

* *Claim for 2 months delay costs (5)*

* *Claim extension of time - 20 months is new time for completion (we allow contractor to decide on time for completion) (6)*

* *Claim for a delay (not an extension of time) (7)*

* *Ask for extension of time (some contractors make a statement on their programme pointing to time between their early completion and the contract time for completion and stating this to be 'period for use by contractor for circumstances other than entitlement to extension of time') (8)*

9 & 10 don't contain this question

* *Claim an extension of time (11)*

Frequency of occurrence and award

Q21 Please state generally on what percentage of contracts extension of time claims with supporting evidence are submitted.

* *75% (1)*

* *Always a letter. Usually other areas dealt with which quash 10-20% (2)*

* *50% (3,7)*

* *Virtually every one (4)*

* *80% (5)*

* *5-10% (6)*

* *60-70% (8)*

* *100% (9)*

* *80% (10)*

* *50% (11)*

Q22 On these contracts, what is the average number of extension of time claims made?

* *2 (1,4,5,8,11)*

* *May be several, can be settled as one at end of day (2)*

* *Some go hideously wrong and you get a number. One claim can lead to another - a snowball effect (3)*

* *1 (6)*

* *Composite claim is made (7)*

* *3 or 4 in 1 year contract (9)*

* *2-3 (10)*

Q23 Do you ever receive claims for extension of time only i.e., without the Contractor, then or later, following up with a claim for overhead costs?

Percentage of total extension of time claims submitted without subsequent attempt to recover O/H costs

this question does not exist on 1-4 & 9-11

* *0% (5)*

* *5-10% (6)*

* *10% (7)*

* *10% or less (8)*

Q23A Of the claims for extension of time and overhead costs submitted with supporting evidence, how often are these granted..

another question which does not exist on 1-4 & 9-11

	time	costs
* in full	*0% (5)*	*0% (5)*
	20% (6)	*10% (6)*
	5% (7)	*20% (7)*
	25-30% (8)	*0-5% (8)*
* in part	*95% (5)*	*80% (5)*
	40-50% (6)	*40% (6)*
	95% (7)	*80% (7)*
	50% (8)	*80% (8)*

24 How accurate is the information you have just given?

1-4 & 9-11 adopt this question - related to similar information

* very accurate

* fairly accurate *(1,4,8,9,10,11)*

← *(5)*

* an impression only *(2,3,6,7)*

Q25 How often are acceleration claims with supporting evidence presented?

percentage of contracts where acceleration claims presented

* *Very low (1)*

* *Very rare 2% (2)*

* *50% (3)*

* *-- (4)*

* *Seldom - need to change the name to a disruption claim for Engineer to pay it (5)*

* *5-10% (6)*

* *Very small (7)*

* *Very rare (8)*

* *Rare (9)*

* *Infrequently (10)*

* *About 10% (11)*

Q26 How often are such claims granted?

* *Generally successful (1)*

* *1 dealt with was granted (2)*

* *75-80% - most contractors have all the facts and figures before they hit you for a claim (3)*

* *-- (4,7,9)*

* *50% (5)*

* *50% (6)*

* *Not a claim - Engineer can't instruct acceleration (8)*

* *Rare - no recollection of granting such a claim (10)*

* *Often (wouldn't submit unless he had a good case - would seek alternative method) (11)*

Q27 How accurate is the information you have just given?

* very accurate *(2,10,11)*
* fairly accurate *(1,3,5)*
* an impression only *(6)*

The following statements represent commonly held views on the subject of delay claims. Please indicate whether you agree or disagree with the views:

	agree/disagree	comment
Q28 There is no point in making a claim for extended overhead costs unless the time for completion is likely to be exceeded.	*disagree: 1,2,3,4,5,6,7 8,9,10,11*	*4 - may be due E of T even if he can still finish on time* *10 - should apply anyway*

	agree/disagree	comment
Q29 If the contract programme (clause 14) showed completion in 18 months and the contractor actually completed in 18 months, no extended overhead costs can ever be justified.	*disagree: 2,3,4,5,6,8 10,11* *agree: 1,9* *neither agree nor disagree: 7*	*2 - could he have used plan elsewhere?* *6 - planned varn of O/H costs through job could be changed by Employer* *8 - if done extra work in that period* *9 - may be grounds for claim due to accelern* *11 - if o/hs over and above what was originally planned are required*

	agree/disagree	comment
Q30 If the Engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the Contractor from justifying an extension of time with recovery of overhead costs for the same period.	*disagree:* *1,2,4,9,10,11* *agree:* *5,6,7,8*	3 - *not sure the argument is sound* 4 - *wouldn't get away with that* 5 - *can justify o/h costs which don't need another E of T* 7 - *contractor would try another way of recovering costs* 11 - *disagree with principle*

	agree/disagree	comment
Q31 Providing the Engineer never actually instructs the Contractor to accelerate, then no acceleration claim can be justified.	*disagree:* *2,4,6,8,9,10,11* *agree:* *1,3,7,*	6 - *failure by Eng would rule out contractrs right to a claim - unfair* 8 - *failure of Eng to carry out obligations to extend contract*

Assessment of claims

Q32 Within your organization, who has the responsibility for assessing the validity of extension of time claims?

* *R.E. in first instance, then Nominated Engineer (1)*
* *R.E. does initial assessment, Nom Engineer has overview and partner accepts (2)*
* *Combined R.E. and Nom Engineer; Nom Engineer gives decision (3)*
* *R.E. makes recommendation, Engineer approves (4)*
* *R.E. in first instance - discuss principles with Contracts dept. - then to director (5)*
* *R.E. does some of work on claim, but chartered engineers in office responsible for the job take the decision (6)*

* *Associate with reference to the partner if necessary (7)*

* *Chief Asst Contracts acting for Engineer (8)*

* *RE produces report - Deputy C. Eng makes final decision (9) (10)*

* *Principle - Engineer; analysis by RE (11)*

Q33 What procedure do you adopt for assessing the validity of a claim for an extension of time on a complex project?

* *Assess actual progress against planned progress (incl extenuating circumstances). Justify that delays were outwith the control of the contractor. Whatever caused the delays couldn't have been expected. (1)*

* *Check dates, plant, facts. Look at claim as though you were making it. Add own data and give response. You get a feeling as to what went on. (2)*

* *Analyse evidence, compare with our records and make a decision based on those facts. (3)*

* *(Projects worked on have not been complex). Usually cut and dry postponement of activities. Vacant possession of bldg not provided on time. (4)*

* *Establish if principle is contractually sound then examine detail of time & detail of cost. Try to establish another 1 or 2 ways to evaluate cost of claim to get a feel for where the settlement figure should lie. Then negotiate with the contractor. (5)*

* *Full list of plant & labour returns and costs. Look at cause of delay, when it happened, how much had been done at that time. Methodical process. Extra countersigned records should be available. (6)*

* *Difficult to specify a general procedure - depends on how the claim is presented. Rely on site records at the end of the day. (7)*

* *Require demonstration that delay has occurred, secondly that delay was critical to completion date. Gets very complicated - anything but straightforward (8)*

* *Identify delays (9)*

* *Use programme - assess links between activities and take into account float (10)*

* *Try to accept contractor's approach, if not use own methods (11)*

Q34 How do you decide whether a delay to a particular activity has actually contributed towards delaying the whole project?

* *Back to the Cl 14 programme + the actual progress chart - will determine how it did affect it (1)*

* *Look at programme and critical path - check for float. If on critical path that's it. Are there consequential effects to accepting this? May advise that another claim would be better. (2)*

* *Does the activity affected lie on the critical path? (may have to be your opinion of the critical path). (3)*

* *Shunting of path by delay (only really one path thro' network therefore very simple situation (for our projects)) (4)*

* *Examine all evidence, including programme. If critical - usually obvious. May have to stall to see if delay is critical. (5)*

* *If something prevents next stage in project from being carried out - goes back to critical path - when something affects critical parts of programme. CP programmes will then appear - either on contractor's behest or Engineer's (6)*

* *Go to Cl 14 programme - decide whether it has a full knock-on effect on project as a whole (7)*

* *Use programme as basis for E of T, but then monitor actual activities + only agree payment if real delay occurs (8)*

* *Judgement of particular activities. Criticality is judged from understanding of sequences of activities (9)*

* *Shunting along + take account of float (10)*

* *Impose own understanding of critical path within bar chart. Typically contractor in claim identifies CP - you check it (11)*

Q35 A number of diagrams have been prepared to illustrate simplified situations in which the Contractor is requesting an extension of time and/or increased costs for delay. Please indicate your views on the Contractor's right to an extension of time and/or increased costs, together with any period for which liquidated damages should be deducted in each case:

	extension of time *(weeks)*	recovery of overheads *(weeks)*	deduct liq. damages *(weeks)*
	0 (1,5,6,7,9,11)	*0 (1,2#,9)*	*0 (1,2,3,4,5,6)*
	1 (2,3,4,8#,10)	*1 (3,4,5,6,7,8)*	*0 (7,8,9,10,11)*
* A		*1 (10,11)*	
	2 (1,2,4,7,8#,9)	*1 (1,2,3,5,6,7,8)*	*0 (1,2,3,4,6,7)*
* B	*2 (10)*	*1 (11)*	*0 (8,9,10,11)*
	1 (3,5,6,11)	*2 (4,9,10)*	*1 (5)*
	2 (1,2,3,4,5,7,8)	*2 (1,3,4,2,9,10,11)*	*0 (1,2,3,4,5,6)*
* C	*2 (9,10,11)*	*1 poss 2 (2)*	*0 (7,8,9,10#)*
	1 (6)	*1 (5,6,7)*	*0 (11)*
		2/0 (8#)	
	1 (1,2#,3,4,6,7,8)	*0 (1,2,3,4,5,6,7)*	*1 (1,2,3,4,7,8)*
* D	*1 (10,11)*	*0 (8,9)*	*1 (10,11)*
	0 (5,9)	*1 (10,11)*	*2 (5,6,9)*

A2# - *if he could prove that he could have used his resources elsewhere - some damages may be payable*

D2# - *depends on attitude and contractor*

A8# - *if he wants it*

B8# - *could renegotiate start date if both parties willing*

C8# - *2 wks cost associated with a; 0 wks cost associated with b*

8# - *o/heads may be in BOQ rates for varied work*

C10# - *assumed no opportunity to share resources*

Q36 Are you aware of the use of as-built CPM schedules to validate extension of time claims in American court hearings?

* *No (1,2,3,4,5,6,7,8,9,11)*

* *No, but not surprised (10)*

Q36A How are decisions on Contractors' claims for delays and extensions of time documented?

* *Keep file of relevant files and documentations on each claim. Auditor needs to be convinced. (1)*

* *State extent of award and say what for. File of relevant data & calculations. 2 lines at the end with justification. (2)*

* *Short report to the client in some situations. (3)*

* *No specific documentation except valuation certificate + form on which extension of time granted has been recorded (4)*

* *Written analysis of contractor's submission leading to award. (5)*

* *Notes (handwritten) on files confirming how time/cost was made up. (6)*

* *Write letter to contractor identifying what has been decided with some explanation. Tell employer at some time. (7)*

* *Separate file for claims - containing reasonings/workings. As much detail in last letters Eng -> Con, Con -> Eng as possible. Formal correspondance should contain as much detail of agreement as possible. File notes used (8)*

* *Report written (11)*

this question did not exist for 9 & 10

RECORD KEEPING

Q37 Please state the methods used for record-keeping on your sites:

bound page-a-day diary	P
loose leaf diary	L
standard record sheets	S
other (please state)	O

	1	2	3	# 4	# 5	6	7	# 8	9	10	11
Resident Engineer	P	L	P	S	O	P	P	P	P	-	P
Senior Engineers	P	-	P	-	P	P	S	L	P+S	-	P
Junior Engineers	P	-	-	S	P	P	S	L	P	-	P
Supervisors	-	L	-	-	S	P	S	-	P	-	P
Inspectors	S	-	L	S	S	P	S	L	P	-	P

COMMENTS

#4 - bound diaries don't have enough room; typed up afterwards

#5 - RE - minutes of meetings/SI's etc

#8 - duplicate books used as these are more secure; there is a set list of headings but these are not pre-printed on the sheets

Q38 Is any standard advice given to the site staff concerning the CONTENT of their site records?

* *Yes, standard manual (1)*

* *Write everything down; engineer records all discussions/instructions/anything else which looks interesting; C of W diary is the main one; photographs are vital (2)*

* *Formal instructions available (3)*

* *Laid out by standard record sheet (4)*

* *Yes, personal sheet of information (5)*

* *Yes, a proforma sheet is used as an aide memoire (6)*

* *RE's briefing kit but not widely used - standard sheets (7)*

* *If site staff are experienced - no need, but otherwise spell out (8)*

* *Experienced engineers/supervisors advise inexperienced staff (9)*

* *RE will instruct his staff (10)*

* *Yes (11)*

Q39 Is any standard advice given to the site staff concerning the LAYOUT of their site records?

* *Inspector yes; otherwise no (1)*

* *Define standard layout in terms of headings for staff (2)*

* *Legible - comprehensible to someone who was not on the site. No specific layout (3)*

* *Pick out key phrase and underline (4)*

* *Diary - no; inspectors - standard sheet (5)*

* *Not standard but agreed between Engineer and RE (6)*

* *Standard record sheet (7)*

* *No (8,11)*

* *Yes (9)*

* *Not sure (10)*

Q40 How are days lost due to adverse weather on the site recorded?

* *By all above separately + agreed with contractor once a month (1)*

* *In the diary (2)*

* *Site diary - supervisor (3)*

* *Recorded at monthly meetings (4)*

* *From the diaries - logged each week and month (try to agree with contractor) (5)*

* *In RE's diaries (6)*

* *RE records days lost (7)*

* *Progress meetings - days lost (8)*

* *Standard sheet - down to 1hr increments (9)*

* *Weekly/fortnightly progress meeting with contractor (11)*

Q41 Is any record made of progress in terms of the specific activities identified on the contract programme?

* *Yes each week working or not (1)*

* *No (2)*

* *Yes on a weekly basis (3)*

* *Weekly assessment of percentage completion (4)*

* *Yes monthly report on percentage completion (5)*

* *Recorded in the minutes of site progress meetings (6)*

* *Not really (7)*

* *At progress meetings - would have to go into detailed records (8)*

* *On some activities yes (9)*

* *Yes percentage complete at intervals (11)*

Q42 Are you generally satisfied with the standard of record-keeping on your sites?

very satisfied *(1#,3,4#,9)*
← *(8)*
quite satisfied *(2#,5,11)*
← *(7)*
not satisfied

COMMENTS *1# - system works*
2# - engineers diaries sometimes not good (often learning); senior staff may be office bound (on site)

4# - do most of it
6# - varies from site to site - some good, some not so

GENERAL

Q43 To whom do you think that any float shown in the Contractor's programme should belong?

Contractor	*(1,2,3#,4,5,7,9,11)*
Employer	*(10#)*
Whoever needs it first	*(6#)*
Other (please specify)	

COMMENTS

* *3# - provided he finishes in the time scale*

* *6# - but generally the contractor*

* *8# - employer can use contractor's float if he doesn't need it*

* *10# - except for weather*

Q43A Do you consider that the wording of Clause 14 with regard to the submission of the contract programme is adequate?

* *Yes (1,2,5,7)*

* *No a spec clause is used to amplify (3)*

* *No prefer amplification which we include (4)*

* *Well tested - better the devil you know (6)*

* *No totally inadequate (8)*

* *Inadequate (11)*

Q43B How frequently do you request a revised programme from the Contractor?

* Every job
* Most jobs *(2,3,4,8,11)* ←——— *(5)(7)*
* Few jobs *(1)(6)*
* Never

COMMENT?

* *Depends on whether programme is approved (8)*

* *Programme is better because contractor has more knowledge of project (11)*

this question does not exist for 9 & 10

Q44 Does the critical path through the project usually change as construction proceeds?

* Yes *(5#,7,8#)*
* No *(1,2#,3#,4#,6#)*
* Don't know *(11)*

9 & 10 did not contain this question

COMMENTS

2# not usually identified (nature of work undertaken)

3# very rare

4# because of type of work

5# some contracts only have one critical path

6# but sometimes does not become truly apparent until well into the job

8# often - not unusual

Q44A Are you always able to identify the critical path for the finished project?

* Yes *(1,2,4,5#,7)*
* No *(3#,8#)*
* Don't know *(11)*

COMMENTS

3# not always

5# doesn't mean to say that I do

8# often with difficulty - can never be certain of analysing the real critical path

Q45 Do the Contractor's site staff have a good working knowledge of the contract programme?

good *(1 agent,2# agent,3 agent,4#,5# agent)*
(6 agent & sometimes GF,8 agent,9,10#,11)

fair *(1 rest,7 agent)*

poor

COMMENTS

2# GF has general appreciation, otherwise unaware

4# but very straightforward

5# others linked into own little bit

10# at top level but not necessarily below that

Q46 Do you ever have network analysis software available for use on your sites?

* *Yes, but only on very large sites (1)*
* *No (2,4,5,8,9,11)*
* *To date no (will on next big job) (3)*
* *Yes, HORNET (6)*
* *Yes, on larger sites (7)*
* *No available at HQ (10)*

Q47 How frequently, if ever, are liquidated damages deducted?

* *Rare but does happen (1)*
* *They are deducted (30%) (2)*
* *Very rare (3,9)*
* *Not very often (4)*
* *Very infrequently (5)*
* *Very rarely 1 - 2% of jobs (6)*
* *Rarely (7)*
* *5 - 10% of cases (8)*
* *Infrequently (has been done) (10)*
* *Never (11)*

Q48 Are there any questions concerning this particular area of contract management which you would like to see included in the questionnaire?

* *Question on how to improve the claims situation on site (good dialogue between parties on site) (1)*
* *Contractor may be asked on a weekly basis to give programme for next*

weeks (not contractually significant & initial programme would still be main tool);how far do personal attitudes affect overall approach to assessing and granting awards;how do you understand the Engineer's position (2)

* *More specific in some areas;need for independent judgement of claims (3)*

* *Area of costs/rates - affects whether he gets paid or not (8)*

* *Anticipation of problems (10)*

* *Do you request details of resources at tender stage? (11)*

APPENDIX 3

RESPONSES TO CONTRACTOR'S QUESTIONNAIRE

RESPONSES TO CONTRACTOR'S QUESTIONNAIRE

Contractor's revised questionnaire (22/9/89)

This questionnaire relates to contracts for civil engineering works which will typically adopt ICE Conditions of Contract, 5th edition.

PROGRAMME FORMAT

Q1 What system of project planning do you adopt within your organisation for the planning of major projects?

* *Major projects: 50% precedence using Hornet. Minor projects: just use bar chart (21)*

* *Limited amount of CPM - basic bar chart mainly (just acquired HORNET - bar charts are result of HORNET CPM) (22)*

* *Bar chart (23)*

* *90% bar chart at tender, rarely do CPM unless specifically asked for in documents. May introduce some links (24)*

* *Plantrak - computer software (25)*

* *Linked bar chart for most small contracts. For large contracts use network approach - HORNET (26)*

* *Superproject expert - both activity on arrow and precedence used (27)*

* *Critical path system (28)*

* *Cascade - linked bar chart (29)*

* *Team of planners - ARTEMIS network (30)*

* *CPM using Plantrak (31)*

Q2 In what format is the Clause 14 programme for projects normally requested by the Employer?

* *Bar chart (21,28)*

* *Not defined other than Cl 14 (22)*

* *Simple bar chart (23)*

* *Often no format defined (24)*

* *Norm is nothing specified (25)*

* *Linked bar chart (26)*

* *Upto 1 yr ago Scottish Development Dept asked for bar chart - now linked bar chart (27)*

* *Often ask for CPM diagram, sometimes no format specified (29)*

* *No norm - time/location, bar charts,network analysis (30)*

* *Left to Cl 14 (31)*

Q3 If a particular format is requested, is this normally laid down in the contract or informally specified?

* *Informal (21,23)*

* *Not typically requested (22,24)*

* *Norm is nothing specified (25)*

* *Informally specified - rely on Cl 14 (26)*

* *Amended Cl 14 (27)*

* *Defined in documents as 'acceptable to Engineer' (28)*

* *Specification clause - not seen Cl 14 changed (29)*

* *Laid down in contract (30)*

* *Left to Cl 14 (31)*

Q4 If the programme format is not defined by the Employer, what format do you normally adopt for the different types of work you undertake?

format	comment
* Bar chart	*most (21)* *all now (22)* *all (23,24,27,28)* *large contracts - stem from CPM (26)* *industrial construction (30)*
* Time-distance diagram	*some r/wks (21,25)* *pipe-lines (29)* *roadworks (30)*
* Linked bar chart	*all previously (22)* *norm (25)* *most contracts - critical path not marked (26)* *major projects (29)* *all (31)*
* CPM (arrow) * CPM (node) * Other (please specify)	

COMMENTS:

* *Just acquired HORNET - hence change (22)*

Q5 Why do you adopt this policy?

* *Bar chart easier to understand (21)*

* *Company policy (22)*

* *Number of major activities makes it unnecessary - no major benefits from use of CPM (23)*

* *Easiest to draw up, easiest to understand (24)*

* *Simplest way of representing what has to be done - for understanding of Contractor & Engineer (25)*

* *Simplest format for everybody connected with the scheme to appreciate (26)*

* *Less work for Contractor to present bar chart - adequate to monitor (27)*

* *Simplicity - easily understood. Sufficient for monitoring purposes (28)*

* *Easiest to understand (Employer & site operations) (29)*

* *Easier to see, more expressive (30)*

* *Not really questioned (31)*

Q6 How does the Engineer normally react to your programme?

* *Request resources, suggest over-ambitious, but generally accept (written acceptance) - press for acceptance (21)*

* *Pass comment on aspects - more detail on some activities - particular activities under/over programmed. Eventually writes to approve (22)*

* *Tries to adapt it to suit his requirements - wrt his information release (providing it is adequate for its purpose) (23)*

* *Either approval or letter requesting alterations (24)*

* *Generally some comment - to varying extent. Rarely approval. Sometimes no response at all (25)*

* *Inspects it. Generally approved with odd comments (26)*

* *Sometimes confirmed as establishing only 'order of procedure'. Often want minor amendments (27)*

* *Pick holes in it - check for key dates - are sequences acceptable, if not are they workable? We try to get written confirmation of programme (28)*

* *Very rarely positive, majority of time no comment, sometimes comment on insufficient time allowed, rarely comment on sequence (29)*

* *Varies - some pedantic + read more into Cl 14 than necessary*
  - some accept without question
  - some question points which are obviously wrong (30)

* *Letter says a little optimistic - more information needed - no approval generally (31)*

Q7 Do you ever show float in the contract programme (if network based)?

* *No (21,23,24,26)*

* *Yes (22,25,27,29,31)*

* *Generally would not show float (tend to have target programme separate to Cl 14 programme to attempt to save prelims (28)*

* *Yes, duration of activity can include float (30)*

Q8 Do you ever show activities in your programmes which are to be carried out by the Engineer?

* *Yes, key dates; flags for info reqd by certain dates; areas to be made available (21)*

* *Yes (22,27,29)*

* *No (23,24)*

* *Key dates for approvals (25)*

* *Yes, tend to be commissioning of machinery (26)*

* *Yes, approval of nominated subcontractors; issue of bending schedules, etc. (28)*

* *Not normally, can come unstuck - consistency (30)*

* *Yes, key dates for pieces of information (31)*

Q9 If so, and if the programme is accepted, do you then consider that the Engineer is bound by those dates/times?

No response from 21 - question changed

* *Yes (22,23,26,28,29)*

* *-- (24,30)*

* *Attempt to make their dates realistic (25)*

* *Yes, often periods quoted in documents (27)*

* *Still comes down to what is reasonable (31)*

Q10 Which activities are the most difficult to properly represent in a project plan?

* *Not sure (21)*

* *Services and finishings - diverse activities often shown in one activity (22)*

* *Those that you know least about (23)*

* *Intermittent activities - finishing parts (24)*

* *Weather sensitive + affected by the tide. Temporary works (not as detailed); sub-contractor's activities (25)*

* *Earthworks and drainage - dependent on weather and ground conditions (26)*

* *Earthworks - assumptions about borrow pits (27)*

* *Anything in main contractor's control is easier than sub-contractor's work (28)*

* *Don't know (29)*

* *No particular problems (30)*

* *Nothing springs to mind (31)*

Q11 How do you represent earthworks (cut/fill) operations on the contract programme?

* *Activities just called earthworks NOT cut & fill (21)*

* *Not involved in much cut/fill work. On current contract cut/fill as one activity (22)*

* *Cut/fill as a single operation (23)*

* *Separate activities for cut and fill (24,25,30)*

* *Separate activities for excn, haulage, compaction & deposition (26)*

* *Separate cut & fill activities with different chainages (27)*

* *Don't have many muckshift contracts (don't do r/works) (28)*

* *Strip & bulk e/wks as one activity (will depend on whether a sub-contractor is used (29)*

* *One activity for excn; one for filling (31)*

Q12 What use do you make of the contract programme during and following the construction process?

* *Used every day of the week to monitor progress on a weekly basis -> weekly programmes (+ resources); by QS to produce cost envelope for Client - Delays. Client asks for CP: Contractor uses CP to prove right. (21)*

* *Planning future activities, bringing on subcontractors, materials. Post contract - to look back at claims situation (22)*

* *Reporting tool; as a planning tool for Contractor; for leverage in discussions with Engineer; to prove effects of delays (23)*

* *Prepare shorter and more detailed programmes - down to weekly programme; monitor progress - used in progress meetings; schedule resources (24)*

* *Monitoring progress (report weekly & monthly); contractual tool - starting point for delay entitlement (25)*

* *DURING - to assess progress of works -> leading to control FOLLOWING - aid to justify extensions of time + durations of extensions (26)*

* *Monitor work done at various stages; resourcing; subcontractors; claims for extension of time (27)*

* *Monitor progress - report back (highlights activities falling behind); used for ordering materials & planning subcontracts; used for compiling claims; budgeting - turnover forecasts (28)*

* *Measure progress against it (break down into areas/weekly/fortnightly); plan & programme works; resources; cost control purposes; requests for extensions of time; provide updated CL 14 to Engineer (29)*

* *Direction for site to work; try to maintain progress in accordance - control; at end produce 'as-built' programme (actual time carrying out activities (30)*

* *Provides skeleton as to how project will be managed; means of monitoring progres on a regular basis; Cl 14 means of monitoring where & how delayed (31)*

Q13 Please indicate your views on the importance of the following uses of the contract programme by ranking them in order, viz, 1 = most important, 3 = least important.

	ranking	comment
* Use as the agreed plan against which the effects of delays to the project may be determined.	3 *(22,23,29)* 2 *(24)* 1 *(21*,25,26,27,28,30,31)*	
* Use to define the agreed method of working and the order in which activities are to be carried out.	3 *(24*,25,26,27)* 2 *(21,28,31)* 1 *(22,23,29*,30)*	
* Use as a control tool against which actual progress may be compared and future action decided.	3 *(21,28)* 2 *(22,23,25,26,27,29,31)* 1 *(24,30)*	

COMMENTS:

* *QS would probably give different views (21)*

* *Generally use another programme developed from Cl 14 but in more detail (24)*

* *As a company (29)*

* *All of equal importance (30)*

* *First most important to QS, second and third most important to company (31)*

EXTENSION OF TIME/ACCELERATION CLAIMS

Q13A Six months into the contract, it is clear that the Employer has delayed a part of the Works in such a way that the whole of the contract will be delayed by 2 months. The time for completion is 24 months and your original programme showed completion in 20 months. What do you do?

Note that No. 21 does not contain this question

* *Claim for disruption rather than E of T (22)*

* *Notify delay + request E of T (23)*

* *Write to Engineer, notify cause of delay + request E of T + addnal costs (24)*

* *Claim an extension of time (25)*

* *Claim for delay and disruption (26)*

* *Notify Engineer of delay + give notice of disruption - not expect to get extension of time (27)*

* *Use Cl 52(4) incurred addnal costs due to effects of others (28)*

* *Request extension of time + costs. Ask Engineer what he wants to do - still complete in 20 mths? Recognizing difference between entitlement and need (29)*

* *Claim extension of time (30)*

* *Claim for 2 months extension of time (31)*

Frequency of occurrence and award

Q14 Please state generally on what percentage of contracts extension of time claims with supporting evidence are submitted.

* *100% (21)*

* *50% (22,27,28)*

* *25% (23)*

* *75% (24)*

* *90% (25,30)*

* *60% (26)*

* *95% (29)*

* *80% (31)*

Q15 On these contracts, what is the average number of extension of time claims made?

* *Could be 10 - 20, depends on the job (21)*

* *Company tends to submit one claim for this area (22)*

* *Unusual to be more than one submission (23)*

* *Lumped together into one claim (24)*

* *One all-embracing claim (25)*

* *1 (26)*

* *One composite claim for E of T (27)*

* *2 - 3 (28)*

* *Impossible to say (29)*

* *Lumped into one claim (30)*

* *Lumped into one (31)*

Q16 Do you ever submit claims for extension of time only, i.e., without then or later following up with a claim for overhead costs?

Percentage of total extension of time claims submitted without subsequent attempt to recover O/H costs

Does not exist on 21-24 & 26-29

* *Never (25)*

* *Nil (30)*

* *Very few (31)*

Q16A Of the claims for extension of time and overhead costs submitted with supporting evidence, how often are these granted :

Another question which does not exist on 21-24 & 26-29.

	time	costs
* in full	*30% (25)* *0% (30,31)*	*0% (25)* *0% (30,31)*
* in part	*70% (25)* *50% (30)* *90% (31)*	*100% (25)* *can't say (30)* *90% (31)*

Q17 How accurate is the information you have just given?

21-24 & 26-29 adopt this question - related to similar information

* very accurate
* fairly accurate *(21,25,26,27,28,30)*
* an impression only *(22,24,31)*

← *(23)*

No response from 29

Q18 How often are acceleration claims with supporting evidence presented?

percentage of contracts where acceleration claims presented

* *50% (mainly result of liability later agreed by Engineer) (21)*
* *Never been involved in one (22)*
* *50% - like to finish on time (23)*
* *10% (24,27)*
* *Don't voluntarily accelerate even though Cl 46 notice (most contractors ignore a Cl 46 notice) Only voluntarily accelerate if our own problem (25)*
* *25% (26)*
* *15% (28)*
* *20% (29)*
* *As-built programme is accelerated programme; Engineer could instruct acceleration under Cl 51; (doesn't appear that way) (30)*
* *15% (31)*

Q19 How often are such claims granted?

* *50% of those submitted may produce some payment (21)*
* *-- (22,25,30)*
* *75% in part (23)*
* *100% (24)*
* *50% (26,27)*
* *80% (28)*

** 60% (29)*

** Both (in my experience) accepted (31)*

Q20 How accurate is the information you have just given?

- very accurate
- fairly accurate *(24,26,27,28,29,31)*
  ← *(23)*
- an impression only *(21)*

No response from 22, 25 & 30

The following statements represent commonly held views on the subject of delay claims. Please indicate whether you agree ordisagree with the views:

	agree/disagree	comment
Q21 There is no point in making a claim for extended overhead costs unless the time for completion is likely to be exceeded .	*disagree: 21,22,23,24,25,26 27,28,29,30,31*	*t for completion only relates to liq damages (25)*
Q22 If the contract programme (clause 14) showed completion in 18 months and the contractor actually completed in 18 months, no extended overhead costs can ever be justified.	*disagree: 21,22,23,24,25,26 27,28,29,30,31*	*got to justify them with records (22)* *resources on site longer than planned (28)* *depends on circum stances (31)*

	agree/disagree	*comment*
Q23 If the Engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the Contractor from justifying an extension of time with recovery of overhead costs for the same period.	*disagree: 21,22,23,24,25, 26,27,28,29* *agree: 30,31*	*has to make separ ate claim for add nal costs (uphill struggle) (22)* * *(qualified) accept all weath er I contract to accept (25)* *Summer work into Winter working (loss of product ivity) (27)* *Prove that should have had in exces of weather extn- plot weather, can cause even more costs (30)*
Q24 Providing the Engineer never actually instructs the Contractor to accelerate, then no acceleration claim can be justified.	*disagree: 21,23,26,27,29,30 31* *agree: 22,24,28*	*See previous response (25)* *failure to award appropriate E of T (27)*

Preparation of claims

Q25 Within your organisation, who has the responsibility for deciding to proceed with extension of time claims?

* *Agent (21)*

* *Starts with agent + continues, unless it becomes contentious;sideways input from Contracts manager + QS (22)*

* *Agent subject to approval of regional manager (23)*

* *Contracts manager (director) (24)*

* *Flag raised by Agent - decision by Project manager or Contracts manager (25)*

* *Area QS + Regional manager (26)*

* *Area QS (27)*

* *Director in charge of job (in discussion with Agent/senior QS) (28)*

* *Extension of time - project QS. Costs - project QS + manager (29)*

* *As laid down in contract form. QS or Agent on site (30)*

* *Site level decision to pick up most circumstances. If a lot of money is to be spent - Assoc. director (31)*

Q26 How do you show that a delay to a particular activity has actually contributed towards delaying the whole project?

* *Via the network (especially when activity is critical) (21)*

* *Back to programme - by extending - that activity has a consequential effect on subsequent activities (22)*

* *By reference to records - depends on circumstances in each particular claim (23)*

* *Manual analysis of network - shunting of critical activities (24)*

* *Only one tool for doing that - the Cl 14 programme (don't show critical path). Starting point is Cl 14 programme; critical path changes - use Cl 14 programme for demonstrating; build up bank of data. Tend to plug in all delays to initial contract programme + if were to use tender resources with theoretical times would give rise to an E of T beyond what is actually needed, because actually resources are increased (does not feel the need to use actual activity durations in this exercise - uses tender durations) (25)*

* *Shunting along of critical activities by delay (resource links included in network) (26)*

* *Use superproject with delay to shunt along critical path and hence prove right to E of T (27)*

* *Set down arguments (narrative); can't identify general approach; lots of research and documentation to do it; good site records are vital - progress reports (28)*

* *Through the programme - shunting along sequence of activities (29)*

* *Its criticality - looked back in retrospect. They adopt an approach which attempts to prove* entitlement *by plugging in all delays to the original network with unamended durations as to what actually took place + with delays retimed in accordance with rate at which the extra work would have been completed with initial tender resources. If project time arrived at in this way is longer than project actually took, then they argue that they have been expeditious in carrying out the project + would be looking for recovery of their costs. (30)*

* *Attempt to use software package + feed in individual delays - generally leave activity durations 'as-planned' (31)*

Q27 A number of diagrams have been prepared to illustrate simplified situations in which a Contractor is requesting an extension of time and/or increased costs for delay. Please indicate your views on the Contractor's right to an extension of time and/or increased costs, together with any period for which liquidated damages should be deducted in each case:

	extension of time (weeks)	*recovery of overheads (weeks)*	*deduct liq. damages (weeks)*
* A	*0(22,23,25,26,27)* *0(28)* *1(21,24,29,30)* *?(31#)*	*0(26,27#)* *1(21,22,23,24,25)* *1(28,29,30#,31)*	*0(21,22,23,24)* *0(25,26,27,28)* *0(29,30,31)*
* B	*1(26,27)* *2(21,22,23,24,25)* *2(28,29,30#,31)*	*1.5 (23)* *1(22,26,27,28)* *2(21#,24,25,29#)* *2(30,31)*	*0(21,22,23,24)* *0(25,26,28,29)* *0(30,31)* *1(27)*
* C	*1(26)* *2(21,22,23,24,25)* *2(27,28,29,30,31)*	*1(26)* *2(21,22,23,24,25)* *2(27,29,31)* *?(28#,30#)*	*0(21,22,23,24)* *0(25,26,27#,28)* *0(29,30,31)*
* D	*0(22,26,30)* *1(21,23,24,25,27)* *1(28,29,31)*	*0(21,22,23,24,25)* *0(26,27,28,29,30)* *0(31)*	*0(23)* *1(21,22,24,25)* *1(27,28,29,31)* *2(26,30)*

COMMENTS:

A27 - No but would have a go

A30 - incl direct costs + loss of profit

A31 - not sought (unless helps with recovery of o/heads)

B21 - Contractor is incurring O/H costs

B29 - minimum of 1 wk

B30 - Contractor could have caught up (we do this)

C27 - Employer's delay is overriding

C28 - overheads, 2 wks for a, 1 wk for b

C30 - apportion o/heads (2wks for a)

Q28 Are you aware of the use of as-built CPM schedules to validate extension of time claims in American court hearings?

* *No (21,22,24,26,29,30,31)*

* *No, have seen them used in UK (not much use) (23)*

* *No, but we use as-constructed programme (25)*

* *Yes (27)*

* *No - have used them ourselves (28)*

RECORD KEEPING

Q29 Please state the methods used for record-keeping on your sites:

bound page-a-day diary P
loose leaf diary L
standard record sheets S
other (please state) O

	21	22	23	24	25	26	27	28	29	30	31
* Agent	P	P	P	P	P	P#	P	P	P	P	P
* Sub-agents	P		P	P	P#	P	S	P	P	P#	P
* Senior engineers	P	P	S	P	P#	P	S	P	P	P#	P#
* Junior engineers	P		S	P	P#	P	-	P	-	P	P#
* Quantity surveyors	P		-	-	P	#	P		P#	S	P
* General foreman	P	P	#	P	P	P	#	L	P	P	P
* Other (please specify)	P	#									

COMMENTS:

22 - Gangers use daily allocation sheets

23 - GF uses a notebook

25 - for all revised situations a standard record sheet is also used

26 - diaries have sub-headings on each day; QS relies on other members

27 - GF uses file allocation sheets

29 - QS diary not page a day - may need more than one page

30 - standard record sheet used also

31 - Senior & junior engineers also use proforma sheet with main part as operations in progress; SE. JE & QS also do labour & matrl return on a daily basis

Q30 Is any standard advice given to the site staff concerning the CONTENT of their site records?

* *Used to have an advice book - not used now (21)*
* *No (22)*
* *Yes, aide-memoire bookmark (23)*
* *Yes, policy document for company (24)*
* *Verbal instruction (25)*
* *Site agent makes staff aware (26)*
* *Check notes on standard sheets (27)*
* *Company bible - lays down content (28)*
* *Monitor how diaries are filled in + act if not acceptable (29)*
* *Yes (30,31)*

Q31 Is any standard advice given to the site staff concerning the LAYOUT of their site records?

* *No (21,22,25,29)*
* *Aide-memoire bookmark (23)*
* *Yes, proforma sheets have been used (24)*
* *Well presented and concise (26)*
* *Laid out for them (standard sheets) (27)*
* *Not defined (28)*
* *Yes (30)*
* *-- (31)*

Q32 How are days lost due to adverse weather on the site recorded?

* *In duplicate book - agreed with RE (21)*
* *Recorded in personal diary + confirmed at progress meeting once a month (22)*
* *Diaries (23,30)*

* *Recorded at progress meetings (24)*

* *In everybody's diary (25)*

* *By site agent - submitted for agreement with client at progress meetings (26)*

* *Daily agreement of resource records with sub-contractors (27)*

* *Agent's diary + weekly report - agreed with RE monthly (28)*

* *(Quietly) in diaries - sometimes Engineer insists on record of days lost (29)*

* *Individual diary sheet - QS keeps running total (31)*

Q33 Is any record made of progress in terms of the specific activities identified on the contract programme?

* *No (21)*

* *Yes, percentage completion at end of month for all activities (gain & loss) (22)*

* *Yes, as-built programme weekly (23)*

* *Yes, weekly assessment of % complete (cumulative activity/week record) (24)*

* *Yes, on a weekly basis (25)*

* *Yes, monthly data sheet gain/loss + % complete (26)*

* *Yes, monthly update - percentage complete (27)*

* *Not generally (28)*

* *Yes, weekly + daily (29)*

* *Yes (30,31)*

Q34 Are you generally satisfied with the standard of record-keeping on your sites?

* very satisfied *(22,25,29,31)*
* quite satisfied *(23#,26#)*
* not satisfied *(21#,24#,27#,28,30)*

COMMENTS:

21 - could always be better

23 - very difficult to get people to do things right

24 - never have enough staff to keep good records (get beat 5 - 0 (by RE))

26 - never totally satisfied from claims viewpoint

27 - never satisfied

GENERAL

Q35 To whom do you think that any float shown in a Contractor's programme should belong?

- Contractor *(21,22#,23#,24,25,26,27,29,30) (31)*
- Employer
- Whoever needs it first *(28)*
- Other (please specify)

COMMENTS:

22# - gives contractor flexibility

23# - don't show float to avoid the argument

Q35A Do you consider that the wording of Clause 14 with regard to the submission of the contract programme is adequate?

This question does not exist on 21

* *Suits the Contractor (22)*
* *Yes (23)*
* *Allright from contractor's point of view (24)*
* *Engineer should be forced to commit himself + approve the programme (25)*
* *No, leaves it open as to whether it is a contract document (26)*
* *No, remove 'order of procedure' (27)*
* *Adequate (28,29)*
* *Sufficiently open (30)*
* *No (31)*

Q36 Does the critical path through the project usually change as construction proceeds?

* Yes *(22,24,25#,26#,27#,28,29#,30,31)*
* No
* Don't know *(23)*

No. 21 did not contain the question

COMMENTS:

25 - often

26 - contracts never go along exact line anticipated

27 - can't think of a job where it didn't change

29 - sometimes

Q36A Are you always able to identify the critical path for the finished project?

* Yes *(22#,24,25,26,29,30#,31)*
* No *(27,28)*
* Don't know *(23)*

No 21 did not contain the question

COMMENT?

22# - with difficulty. Always going to have a critical path through each structure (when more than one at once)

30# - may have more than one

Q37 Do the Engineer's site staff have a good working knowledge of the contract programme?

* good *(24 RE + staff ,25# RE,26, 28 RE,29# RE)*

* fair *(21,22#,23,31 RE)*

* poor *(27#, 28 assistants,30)*

COMMENTS:

22 - REs spend a lot of time going through programme (LAs more than consultants) + looking at its implications

25 - He doesn't know background (learning curves)

27 - This is to the contractor's disadvantage because they don't understand the basic concepts of tendering

29 - depends on size of job (seniority of RE)

31 - some good, some not a clue

Q38 Do you ever have network analysis software available for use on your sites?

* *In HQ - site go back to use it (21)*

* *Not on site - at HQ (22)*

* *Yes nationally (23)*

* *No (24,26)*

* *Yes (25,27,28,30,31)*

* *Yes, HORNET (29)*

Q39 How frequently, if ever, are liquidated damages deducted?

* *Infrequent to never (21)*

* *Last job they were taken (22)*

* *Very infrequently (no knowledge of ever) (23)*

* *Never (24)*

* *Agent for 14 years - never had a contract where deducted (25)*

* *5% (26)*

* *1% (27)*

* *Very rare (28,29)*

* *Not on major contracts - rare (30)*

* *No experience of that (31)*

Q39A How do you formulate claims when the disruption to progress is due to the effects of a large number of site instructions and it is not possible to separate individual causes of delay?

* *Attempt to identify individual causes of delay and combine (22)*

* *If claim is valid, amass info on instructions + info on costs (23)*

* *List SI's and make general comment that these have caused disruption (24)*

* *Using computer - we can separate delays (25)*

* *Evaluate value of instructions, relate to initial contract sum. Show how actual monies spent compare with anticipated (spending profile) (26)*

* *With difficulty. Need to go into detail, more explanation (27)*

* *Try to extract key instructions + leave remainder as 'sweep-up' (28)*

* *First step is to allocate resources + time to each SI + add up. Percentage of SI value cf tender sum. Most of time consider each individual delay (29)*

* *Entitlement (30)*

* *Should typically be possible to identify delays (31)*

Q40 Are there any questions concerning this particular area of contract management which you would like to see included in the questionnaire?

* *Buggeration effect (21)*

* *How to learn from past experience of programme not living up to requirements for better input to next programme. Programmes frequently at tender stage - what significance? (22)*

* *More emphasis on control; would you like a copy of the findings? (23)*

* *Evaluation of disruption looked at in place of acceleration (25)*

* *No (26)*

* *The importance of negotiating and presentation skills in presenting claims (27)*

* *Engineers need better training in management; management contracting has problems - contractors telling contractors (30)*

* *Do companies use specialized companies to recover claims for them rather than in-house staff? Reputation of firms in terms of claims aggressiveness; entitlement associated with planned durations - reflects agreed planned income through BOQ; dealing with one-off personalities (31)*

APPENDIX 4

RECORD-KEEPER COMPUTER PROGRAM

```
      PROGRAM RECORDKEEPER
      PARAMETER (MAX = 200)
      INTEGER PICK,INPICK,DPICK,RD,RM,RY,LY,NYD,REK,ORDR,FPOS,FFPOS,
     $LPOS,LNUM,FDMON,FREK,FRPOS,START,WKNO,INTUNO
      INTEGER MTOD(12)
      INTEGER MTODL(12)
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
      INTEGER*4 J,NUM
      CHARACTER*3 MNTH(12)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 EN
      CHARACTER*1 YESNO
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*1 WKDAT(MAX,55)
 15   FORMAT(A1)
 45   FORMAT(A4)
 55   FORMAT(A6)
      COMMON AL

      INCLUDE 'SYSREG'
      DO 10 L = 1,MAX
        INTS(L) = L
  10  CONTINUE
      CALL CLEAR
      CALL DATAIN(FNAME,CNAME)
      CALL SIMP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR,LY
     $,FREK,DPICK,FDMON,FRPOS,START,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
      STOP
      END
***************************************************************************
      SUBROUTINE INPUT2(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
***************************************************************************
C  COD        - Character array holding activity codes
C  DESC       - Character array holding activity descriptions
C  FNAME      - Name of file holding COD and DESC
C  CNAME      - Contract name
C  RD,RM,RY   - Record date
C  FPOS       - Position in arrays COD and DESC
C  FFPOS      - Number of first record on screen
C  LPOS       - Number of last record in COD or DESC
C  LNUM       - Screen line number
C
C This program is the main INPUT program for RECORDKEEPER.
C  It reads information from the file FNAME and displays it on
C  the screen, allowing it to be scrolled and for particular
C  activities to be highlighted with the cursor.  The user can
C  then input activity progress information concerning the activity
C  currently highlighted in the form of a number of options.
C  Following input this information is then read to a temporary
```

```
C  file from where it may be saved to the main records matrix.

      PARAMETER (MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,I,FPOS,FFPOS,LPOS,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,AL,INTUNO
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
 55   FORMAT(A6)
      COMMON AL

      CALL CLEAR
      CALL RDFIL1(FNAME,COD,DESC,LPOS,INTS)
      CALL INPUT3(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
      RETURN
      END
************************************************************************
      SUBROUTINE SIMP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR,LY
     $,FREK,DPICK,FDMON,FRPOS,START,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
************************************************************************
C     Deals with the selection from MMENU

      PARAMETER (MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,I,FPOS,FFPOS,LPOS,REK,LNUM,NYD,PICK,WKNO
      INTEGER INPICK,ORDR,LY,FREK,DPICK,FDMON,FRPOS,START,AL,INTUNO
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
      COMMON AL

      CALL CLEAR
 10   CALL MMENU(PICK)
      IF(PICK.EQ.2)THEN
        CALL CLEAR
        CALL MINP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $  ,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $  ,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
      ELSE IF(PICK.EQ.4)THEN
        CALL CLEAR
```

```
        CALL DINP(FNAME,CNAME,COD,DESC,MATRIX,RD,RM,RY,FREK,REK,LY,
     $  FDMON,NYD,DPICK,FRPOS,START,FPOS,LPOS,TREC,YESNO,FFPOS,LNUM
     $  ,PICK,INPICK,ORDR,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
      ELSE IF(PICK.EQ.7)THEN
        CALL CLEAR
        STOP
      ELSE
        CALL CLEAR
        GOTO 10
      END IF
      RETURN
      END
************************************************************************
      SUBROUTINE INPUT3(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
************************************************************************
C     The main program for input  of  activity  progress.   Using  a
C     continuous 'read' loop the program is directed to either scroll,
C     move the highlight or to input activity progress information.

      PARAMETER(MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO,EN,FUN
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,I,FPOS,FFPOS,LPOS,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,INTUNO
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
      LOGICAL DOSIT
    5 FORMAT(3I2)
   35 FORMAT(T2,A4,T9,A18)
  125 FORMAT(A,\)
  135 FORMAT(1X,A)
      COMMON AL

      INCLUDE 'SYSREG'
      WRITE(*,135)'What is the record date (in the form DDMMYY)?'
      READ(*,5)RD,RM,RY
      EN = CHAR(48 + MOD(RY,88))
      INQUIRE(FILE = FNAME(1:4)//EN,EXIST = DOSIT)
      IF(DOSIT)THEN
        CONTINUE
      ELSE
        CALL CLEAR
        CALL CURPOS(10,12)
        WRITE(*,135)'NO FILE EXISTS YET FOR THIS YEAR. IF YOU WISH TO'
        CALL CURPOS(17,14)
        WRITE(*,135)'CONTINUE PRESS Y, OTHERWISE PRESS N'
        READ(*,125) FUN
        IF(FUN.EQ.'Y'.OR.FUN.EQ.'y')THEN
          CONTINUE
```

```
    ELSE
      GOTO 40
    END IF
  END IF
  CALL SPECYR(RD,RM,RY,NYD,REK,LY)
  CALL RDTREC(FNAME,REK,TREC,MATRIX,RY)
  FPOS = 0
  CALL CLEAR
  CALL SCRDN(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS)
  CALL OPTION(RD,RM,RY)
  CALL CURPOS(10,24)
  WRITE(*,125)' COMMAND ?'
  DO 10 I = 1,1000
    AH = $07
    CALL SYS1(SYSREG)
    IF(AL.EQ.$5B)THEN
      CALL CLEAR
      CALL SCRDN(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS)
      CALL OPTION(RD,RM,RY)
    ELSE IF(AL.EQ.$5D)THEN
      CALL CLEAR
      CALL SCRUP(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS)
      CALL OPTION(RD,RM,RY)
    ELSE IF(AL.EQ.$3D)THEN
      CALL HIGHDN(COD,DESC,FPOS,FFPOS,LNUM,INTS)
    ELSE IF(AL.EQ.$2D)THEN
      CALL HIGHUP(COD,DESC,FPOS,FFPOS,LNUM,INTS)
    ELSE IF(AL.EQ.$58.OR.AL.EQ.$48.OR.AL.EQ.$57.OR.AL.EQ.$52
 $  .OR.AL.EQ.$78.OR.AL.EQ.$68.OR.AL.EQ.$77.OR.AL.EQ.$72.OR.
 $  AL.EQ.$20.OR.AL.EQ.$44.OR.AL.EQ.$64)THEN
      CALL INPUT4(LNUM,FPOS,TREC,LPOS,FFPOS,INTS,COD)
    ELSE IF(AL.EQ.$46.OR.AL.EQ.$66)THEN
      CALL CLEAR
      CALL ENDIN(FNAME,TREC,LPOS,YESNO,RD,RM,RY,WKDAT,WKNO,INTS,
 $    INTT,INTU,INTUNO)
      IF(YESNO.EQ.'Y'.OR.YESNO.EQ.'y')THEN
        GOTO 30
      ELSE
        GOTO 40
      END IF
    ELSE
      CONTINUE
    END IF
10  CONTINUE
30  CALL CLEAR
    CALL SAVIT(FNAME,RY,TREC,REK,MATRIX)
    CALL WATWK(NYD,RY,REK,WKNO)
    CALL RITEWK(FNAME,WKNO,TREC,WKDAT,RY)
    DO 40 J = 1,MAX
      TREC(J) = ' '
40  CONTINUE
    CALL CLEAR
    CALL MINP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
   $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
   $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
20  CALL CLEAR
    RETURN
    END
```

```
************************************************************************
      SUBROUTINE DINP(FNAME,CNAME,COD,DESC,MATRIX,RD,RM,RY,FREK,REK,LY,
     $FDMON,NYD,DPICK,FRPOS,START,FPOS,LPOS,TREC,YESNO,FFPOS,LNUM
     $,PICK,INPICK,ORDR,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
************************************************************************
C     Deals with the output from the display menu DMENU

      PARAMETER(MAX=200)
      CHARACTER*2 YEND(12)
      CHARACTER*4 YERE
      CHARACTER*1 EN
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*3 MONTH(12)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*10 CNAME
      CHARACTER*6 FNAME
      CHARACTER*1 MATRIX(MAX,367)
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,FREK,REK,FDMON,LY,NYD,NYDCUM,DPICK,XXX,YYY,WKNO
      INTEGER FPOS,LPOS,FFPOS,LNUM,PICK,INPICK,ORDR,FRPOS,START,FRST
      INTEGER INTUNO
      INTEGER MTOD(12)
      INTEGER MTODL(12)
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
      LOGICAL DOSIT
  45  FORMAT(I2)
  75  FORMAT(A1)
 125  FORMAT(A)
 135  FORMAT(1X,A,\)

      INQUIRE(FILE = FNAME,EXIST = DOSIT)
      IF(DOSIT)THEN
        CONTINUE
      ELSE
        CALL CLEAR
        CALL CURPOS(10,12)
        WRITE(*,135)'NO ACTIVITY LIST EXISTS FOR THIS FILE:PRESS A KEY'
        READ(*,*)
        GOTO 60
      END IF
  10  CALL DMENU(DPICK)
      DO 20 J = 1,MAX
        INTS(J) = J
  20  CONTINUE
  40  IF(DPICK.EQ.1)THEN
        CALL CLEAR
        CALL ORDER(ORDR)
        IF(ORDR.EQ.1)THEN
          CALL RDFIL1(FNAME,COD,DESC,LPOS,INTS)
          CALL DISPLY(FNAME,CNAME,COD,DESC,MATRIX,RD,RM,RY,FREK,REK,LY
     $    ,FDMON,NYD,DPICK,FRPOS,START,FPOS,LPOS,TREC,YESNO,FFPOS,LNUM,
     $    PICK,INPICK,ORDR,WKDAT,WKNO,ST,INTS)
          CALL CLEAR
          GOTO 10
```

```
        ELSE IF(ORDR.EQ.3)THEN
   50     CALL RDFIL1(FNAME,COD,DESC,LPOS,INTS)
          DO 30 L = 1,MAX
            INTT(L) = 0
            INTU(L) = 0
   30     CONTINUE
          CALL INPUT5(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $    ,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $    ,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
          LPOS = INTUNO
          CALL DISPLY(FNAME,CNAME,COD,DESC,MATRIX,RD,RM,RY,FREK,REK,LY
     $    ,FDMON,NYD,DPICK,FRPOS,START,FPOS,LPOS,TREC,YESNO,FFPOS,LNUM
     $    ,PICK,INPICK,ORDR,WKDAT,WKNO,ST,INTS)
          CALL CLEAR
          GOTO 10
        END IF
      ELSE IF(DPICK.EQ.2)THEN
        CALL DISPYR(FNAME,CNAME,COD,DESC,RY,FPOS,LPOS,FFPOS,LNUM,WKDAT,
     $  WKNO,ST,INTS)
        CALL CLEAR
        GOTO 10
      ELSE IF(DPICK.EQ.3)THEN
  60    CALL CLEAR
        CALL SIMP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $  ,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR,LY
     $  ,FREK,DPICK,FDMON,FRPOS,START,WKDAT,WKNO,INTS,INTT,INTU,INTUNO
     $  )
      ELSE
        GOTO 40
      END IF
      RETURN
      END
************************************************************************
      SUBROUTINE SCRDNA(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS,INTT)
************************************************************************
C     Scrolls the screen contents (COD & DESC) down 20 places through
C     the file.  Used for selecting activities.

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      INTEGER INTS(MAX)
      INTEGER INTT(MAX)
      INTEGER FPOS,FFPOS,LNUM,LPOS,AL
  25  FORMAT(T2,'Code',T9,'Activity Description',T33,'Selection'/)
  35  FORMAT(T2,A4,T9,A18)
  45  FORMAT(1X,A,\)
  55  FORMAT(T35,I3)
      COMMON AL

      WRITE(*,25)
      J = 0
      FFPOS = FPOS + 1

C     Tests for last page of the file - if found, further calls simply
C     replace that last page.
```

```
      IF(FFPOS.GT.LPOS)THEN
        IF(MOD(LPOS,20).EQ.0)THEN
          FFPOS = LPOS - 19
          FPOS = FFPOS - 1
        ELSE
          FFPOS = LPOS - MOD(LPOS,20) + 1
          FPOS = FFPOS - 1
        END IF
      ELSE
        GOTO 20
      END IF

C      Ensures that only 20 lines are shown.

   20 IF(J.EQ.20)GOTO 30
      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')THEN
        GOTO 30
      ELSE
        J = J + 1
        FPOS = FPOS + 1
        WRITE(*,35)COD(INTS(FPOS)),DESC(INTS(FPOS))
        GOTO 20
   30 END IF

C     Positions the highlight on the first activity on the screen.

      CALL CURPOS(1,3)
      CALL ATRIB(7)
      WRITE(*,45)COD(INTS(FFPOS))
      CALL CURPOS(8,3)
      WRITE(*,45)DESC(INTS(FFPOS))
      CALL ATRIB(0)
      LNUM = 1
      RETURN
      END
************************************************************************
      SUBROUTINE SCRUPA(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS,INTT)
************************************************************************
C     Scrolls the screen contents (COD & DESC) up 20 places through the
C     file.  Used for selecting activities.

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      INTEGER INTT(MAX)
      INTEGER INTS(MAX)
      INTEGER FPOS,FFPOS,LNUM,LPOS,AL
   25 FORMAT(T2,'Code',T9,'Activity Description',T33,'Selection'/)
   35 FORMAT(T2,A4,T9,A18)
   45 FORMAT(1X,A,\)
   55 FORMAT(T35,I3)
      COMMON AL
C     Tests for the current position in the file

      IF(MOD(FPOS,20).EQ.0)THEN
        FPOS = FPOS - 40
      ELSE IF(FPOS.LT.20)THEN
```

```
        FPOS = 0
      ELSE
        FPOS = FPOS - (20 + MOD(FPOS,20))
      END IF
      IF(FPOS.EQ.-20)FPOS = 0

C     Writes up 20 lines of the file

      FFPOS = FPOS + 1
      WRITE(*,25)
      K = 0
   40 IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx'.OR.K
     .EQ.$20)THEN
        GOTO 50
      ELSE
        K = K + 1
        FPOS = FPOS + 1
        WRITE(*,35)COD(INTS(FPOS)),DESC(INTS(FPOS))
        GOTO 40
   50 END IF

C     Positions the highlight on the first activity on the screen.

      CALL CURPOS(1,3)
      CALL ATRIB(7)
      WRITE(*,45)COD(INTS(FFPOS))
      CALL CURPOS(8,3)
      WRITE(*,45)DESC(INTS(FFPOS))
      CALL ATRIB(0)
      LNUM = 1
      RETURN
      END
************************************************************************
      SUBROUTINE SELECT
************************************************************************
C     Gives instructions for selecting activities

  125 FORMAT(1X,A,\)

      CALL CURPOS(42,5)
      WRITE(*,125)'INSTRUCTIONS FOR SELECTION'
      CALL CURPOS(42,9)
      WRITE(*,125)'To select an activity, move'
      CALL CURPOS(42,11)
      WRITE(*,125)'the highlight to the activity'
      CALL CURPOS(42,13)
      WRITE(*,125)'to be selected and press the'
      CALL CURPOS(42,15)
      WRITE(*,125)'       ''S''      '
      CALL CURPOS(42,18)
      WRITE(*,125)'Press F to finish'
      RETURN
      END
************************************************************************
      SUBROUTINE ENDSEL(FNAME,LPOS,YESNO,INTS,INTT,INTUNO)
************************************************************************
C     Checks to make sure that the user wishes to end the input session
C     and then writes LPOS as the last entry in INTS
```

```
      PARAMETER (MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 YESNO
      INTEGER INTT(MAX)
      INTEGER INTS(MAX)
      INTEGER FPOS,LPOS,FFPOS,RD,RM,RY,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,INTUNO
  125 FORMAT(A,\)
  145 FORMAT(1X,I3)
C     CALL CURPOS(16,12)
C     WRITE(*,125)' Do you want to end the input session (Y/N)?'
C     READ(*,125)YESNO
C     IF(YESNO.EQ.'Y'.OR.YESNO.EQ.'y')THEN
        DO 20 J = 1,INTUNO
          DO 40 L = 1,LPOS
            IF(INTT(L).EQ.J) INTS(J) = L
 40       CONTINUE
 20     CONTINUE
        INTUNO = INTUNO + 1
        INTS(INTUNO) = LPOS
C     ELSE
C       CONTINUE
C     END IF
      RETURN
      END
***********************************************************************
      SUBROUTINE INPUT5(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
***********************************************************************
C     The main calling program - using a continuous 'read' loop the
C     program is directed to either scroll, move the highlight or to
C     make activity selections.

      PARAMETER(MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,I,FPOS,FFPOS,LPOS,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,INTUNO
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
  125 FORMAT(A,\)
  135 FORMAT(1X,A)
      COMMON AL

      INCLUDE 'SYSREG'
      FPOS = 0
      INTUNO = 0
      CALL CLEAR
      CALL SCRDNA(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS,INTT)
      CALL DISINT(FFPOS,INTT)
```

```
      CALL SELECT
      CALL CURPOS(10,24)
      WRITE(*,125)' COMMAND ?'
      DO 10 I = 1,1000
        AH = $07
        CALL SYS1(SYSREG)
        IF(AL.EQ.$5B)THEN
          CALL CLEAR
          CALL SCRDNA(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS,INTT)
          CALL DISINT(FFPOS,INTT)
          CALL SELECT
        ELSE IF(AL.EQ.$5D)THEN
          CALL CLEAR
          CALL SCRUPA(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS,INTT)
          CALL DISINT(FFPOS,INTT)
          CALL SELECT
        ELSE IF(AL.EQ.$3D)THEN
          CALL HIGHDN(COD,DESC,FPOS,FFPOS,LNUM,INTS)
        ELSE IF(AL.EQ.$2D)THEN
          CALL HIGHUP(COD,DESC,FPOS,FFPOS,LNUM,INTS)
        ELSE IF(AL.EQ.$53.OR.AL.EQ.$73)THEN
          CALL INPUT6(LNUM,FPOS,TREC,LPOS,FFPOS,INTS,INTT,INTU,INTUNO,
     $    ,COD)
          CALL DISINT(FFPOS,INTT)
        ELSE IF(AL.EQ.$46.OR.AL.EQ.$66)THEN
          CALL CLEAR
          CALL ENDSEL(FNAME,LPOS,YESNO,INTS,INTT,INTUNO)
          GOTO 30
        ELSE
          CONTINUE
        END IF
   10 CONTINUE
   30 CALL CLEAR
      RETURN
      END
***********************************************************************
      SUBROUTINE INPUT6(LNUM,FPOS,TREC,LPOS,FFPOS,INTS,INTT,INTU,INTUNO
     $,COD)
***********************************************************************
C     Deals with activity selections

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      INTEGER INTS(MAX)
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER LNUM,FPOS,FFPOS,LPOS,AL,INTUNO
  125 FORMAT(1X,I3,\)
      COMMON AL


C     Checks if SCRDN/SCRUP have just been called and if so ensures
C     that input is directed to FFPOS;(SCR** leave FPOS as last value
C     on the screen although first value is highlighted).


      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')
$GOTO 20
```

```
      IF(INTT(FPOS).NE.0)THEN
        DO 10 J = 1,LPOS
          IF(INTT(J).GT.INTT(FPOS)) INTT(J) = INTT(J) - 1
 10     CONTINUE
        INTT(FPOS) = 0
        CALL DISINT(FFPOS,INTT)
        INTUNO = INTUNO - 1
      ELSE
        INTUNO = INTUNO + 1
        INTT(FPOS) = INTUNO
        CALL DISINT(FFPOS,INTT)
      END IF
 20   RETURN
      END
***********************************************************************
      SUBROUTINE MINP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
***********************************************************************
C     Deals with the output from the input menu

      PARAMETER (MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER RD,RM,RY,I,FPOS,FFPOS,LPOS,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,AL,INTUNO
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER INTS(MAX)
      LOGICAL DOSIT
      COMMON AL
 135  FORMAT(1X,A,\)

 80   CALL INMENU(INPICK)
      IF(INPICK.EQ.1)THEN
        CALL CLEAR
        INQUIRE(FILE=FNAME,EXIST=DOSIT)
        IF(DOSIT)THEN
          CALL CURPOS(10,12)
          WRITE(*,135)'FILE ALREADY EXISTS PRESS ANY KEY TO CONTINUE'
          READ(*,*)
          CALL CLEAR
          GOTO 80
        ELSE
          CALL INPUT1(FNAME,COD,DESC,INTS)
          CALL CLEAR
          GOTO 80
        END IF
      ELSE IF(INPICK.EQ.2)THEN
        INQUIRE(FILE = FNAME,EXIST = DOSIT)
        IF(DOSIT)THEN
          CONTINUE
```

```
         ELSE
           CALL CLEAR
           CALL CURPOS(10,12)
           WRITE(*,135)'NO ACTIVITY LIST EXISTS FOR THIS FILE: PRESS A
     $KEY'
           READ(*,*)
           CALL CLEAR
           GOTO 80
         END IF
         CALL CLEAR
         DO 10 l = 1,MAX
           INTS(L) = L
  10     CONTINUE
         CALL ORDER(ORDR)
         IF(ORDR.EQ.1)THEN
           CALL CLEAR
           CALL INPUT2(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $     ,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $     ,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
         ELSE IF(ORDR.EQ.3)THEN
           CALL CLEAR
           CALL RDFIL1(FNAME,COD,DESC,LPOS,INTS)
           DO 20 J = 1,MAX
             INTT(J) = 0
             INTU(J) = 0
  20       CONTINUE
           CALL INPUT5(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $     ,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR
     $     ,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
           LPOS = INTUNO
           CALL SEINTS(INTS,LPOS)
           CALL INPUT3(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS,LPOS,TREC
     $     ,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR,WKDAT,
     $     WKNO,INTS,INTT,INTU,INTUNO)
         ELSE
           GOTO 80
         END IF
       ELSE IF(INPICK.EQ.3)THEN
         CALL CLEAR
         CALL SIMP(FNAME,CNAME,RD,RM,RY,COD,DESC,FPOS
     $,LPOS,TREC,YESNO,REK,FFPOS,LNUM,MATRIX,NYD,PICK,INPICK,ORDR,LY
     $,FREK,DPICK,FDMON,FRPOS,START,WKDAT,WKNO,INTS,INTT,INTU,INTUNO)
       ELSE
         GOTO 80
       END IF
       RETURN
       END
***********************************************************************
       SUBROUTINE DISINT(FFPOS,INTT)
***********************************************************************
C      Puts up the activity selections from INTT on the screen

       PARAMETER(MAX=200)
       INTEGER FFPOS
       INTEGER INTT(MAX)
 125   FORMAT(1X,I3,\)
 135   FORMAT(1X,A,\)
```

```
      DO 10 J = 0,19
        IF(INTT(FFPOS+J).NE.0)THEN
          CALL CURPOS(34,J+3)
          WRITE(*,125)INTT(FFPOS+J)
        ELSE
          CALL CURPOS(34,J+3)
          WRITE(*,135)'   '
        ENDIF
 10   CONTINUE
      RETURN
      END
**********************************************************************
      SUBROUTINE MMENU(PICK)
**********************************************************************
C     Puts the main menu on the screen

      INTEGER PICK
 85   FORMAT(I1)
 105  FORMAT('                 ***********************',/'              RE
     $CORD-KEEPER',/'              ***********************',/'
     $   MAIN MENU',/'             ***********************',//' Please s
     $elect from the following:',//'  1) HELP, explanation of the prog
     $ram',//'  2)  INPUT, information about the contract',//'  3)  EDI
     $T,information currently held about the contract',//'  4)  DISPLAY
     $, information held on an existing file',//'  5)  SAVE, informatio
     $n to disk',//'  6)  INTERROGATE, the system',//'  7)  EXIT, to
     $the operating system',///'  CHOICE ? :')
      WRITE(6,105)
      READ(*,85)PICK
      RETURN
      END
**********************************************************************
      SUBROUTINE INMENU(INPICK)
**********************************************************************
C     Puts the input menu on the screen.

      INTEGER INPICK
 85   FORMAT(I1)
 95   FORMAT('                 **********************',/'
     $INPUT MENU',/'               **********************',//'  Please se
     $lect from the following:',//'  1) ACTIVITIES, input data on activ
     $ities',//'  2) RECORDS, input records of activities',//'  3) RETU
     $RN to the main menu'///'  CHOICE ? :')
      WRITE(6,95)
      READ(*,85)INPICK
      RETURN
      END
**********************************************************************
      SUBROUTINE ORDER(ORDR)
**********************************************************************
C     Allows user to decide which ordering of activities to adopt.

      INTEGER ORDR
 85   FORMAT(I1)
 115  FORMAT('                 ************************',/'
     $ACTIVITY ORDER SELECTION',/'              **********************
     $*',//'  Please select from the following :',//' 1) ORIGINAL order
     $ing of activities (as input)',//' 2) CURRENT ordering, only activ
```

```
     $ities worked on in last two weeks shown',//' 3) SELECT order of a
     $ctivities to be shown',///' CHOICE ? :')
      WRITE(6,115)
      READ(*,85) ORDR
      RETURN
      END
*************************************************************************
      SUBROUTINE CLEAR
*************************************************************************
C     Simply clears the screen

      CHARACTER*1 CH
      CH=CHAR(27)
      WRITE(*,'(1X,2A,\)') CH,'[2J'
      RETURN
      END
*************************************************************************
      SUBROUTINE RDFIL1(FNAME,COD,DESC,LPOS,INTS)
*************************************************************************
C     Reads the original file of activities, FNAME

      PARAMETER(MAX = 200)
      CHARACTER*6 FNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER LPOS
      INTEGER INTS(MAX)
  5   FORMAT(3I2)
 35   FORMAT(T2,A4,T9,A18)
 55   FORMAT(A6)
 65   FORMAT(A10)

      OPEN(9,FILE = FNAME)
      REWIND 9
      K = 0
 20   IF(COD(INTS(K)).EQ.'XXXX'.OR.COD(INTS(K)).EQ.'xxxx'.OR.K.EQ.MAX)
     $THEN
        LPOS = K
        CLOSE(9)
      ELSE
        K = K + 1
        READ(9,35)COD(INTS(K)),DESC(INTS(K))
        GOTO 20
      END IF
      RETURN
      END
*************************************************************************
      SUBROUTINE CURPOS(N,M)
*************************************************************************
C     Moves the cursor to column N, line M.

      CHARACTER*1 ESC
      ESC=CHAR(27)
      IF (N.GT.9.AND.M.GT.9) WRITE(*,100) ESC,'[',M,';',N,'H'
      IF (N.GT.9.AND.M.LE.9) WRITE(*,101) ESC,'[',M,';',N,'H'
      IF (N.LE.9.AND.M.GT.9) WRITE(*,102) ESC,'[',M,';',N,'H'
      IF (N.LE.9.AND.M.LE.9) WRITE(*,103) ESC,'[',M,';',N,'H'
  100 FORMAT(1X,2A,I2,A,I2,A,\)
```

```
  101 FORMAT(1X,2A,I1,A,I2,A,\)
  102 FORMAT(1X,2A,I2,A,I1,A,\)
  103 FORMAT(1X,2A,I1,A,I1,A,\)
      RETURN
      END
*****************************************************************
      SUBROUTINE ATRIB(L)
*****************************************************************
C     Used here to produce the highlight, when L = 7.

      CHARACTER*1 ESC
      ESC=CHAR(27)
      WRITE(*,'(1X,2A,I1,A,\)') ESC,'[',L,'m'
      RETURN
      END
*****************************************************************
      SUBROUTINE OPTION(RD,RM,RY)
*****************************************************************
C     SHOWS THE COMMAND AND INPUT OPTIONS AVAILABLE IN INPUT2

      CHARACTER*3 MNTH(12)
      INTEGER RD,RM,RY
      DATA MNTH/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP'
     $,'OCT','NOV','DEC'/
 135  FORMAT(1X,I2,':',A3,':',I2)
 125  FORMAT(1X,A,\)
      CALL CURPOS(42,3)
      WRITE(*,125)'COMMAND OPTIONS'
      CALL CURPOS(42,5)
      WRITE(*,125)'KEY  EFFECT'
      CALL CURPOS(42,7)
      WRITE(*,125)' ]   scroll up'
      CALL CURPOS(42,8)
      WRITE(*,125)' [   scroll down'
      CALL CURPOS(42,9)
      WRITE(*,125)' =   cursor down'
      CALL CURPOS(42,10)
      WRITE(*,125)' -   cursor up'
      CALL CURPOS(42,11)
      WRITE(*,125)' F   end input'
      CALL CURPOS(42,13)
      WRITE(*,125)'INPUT OPTIONS'
      CALL CURPOS(42,15)
      WRITE(*,125)'KEY  MEANING'
      CALL CURPOS(42,17)
      WRITE(*,125)' X   working all day'
      CALL CURPOS(42,18)
      WRITE(*,125)' H   working half day'
      CALL CURPOS(42,19)
      WRITE(*,125)' W   not working all day'
      CALL CURPOS(47,20)
      WRITE(*,125)'due to weather'
      CALL CURPOS(42,21)
      WRITE(*,125)' R   not working half day'
      CALL CURPOS(47,22)
      WRITE(*,125)'due to weather'
      CALL CURPOS(42,23)
      WRITE(*,125)' D   delay effective'
```

```
      CALL CURPOS(50,1)
      WRITE(*,135)RD,MNTH(RM),RY
      RETURN
      END
***********************************************************************
      SUBROUTINE SAVIT(FNAME,RY,TREC,REK,MATRIX)
***********************************************************************
C     Saves the temporary record TREC to the main records matrix MATRIX

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*1 EN
      INTEGER RY,REK
      INTEGER*4 J,NUM
   15 FORMAT(A1)
  125 FORMAT(A,\)
  145 FORMAT(A1)
      CALL CURPOS(10,12)
      WRITE(*,125)' Press any key to save these records to the main mat
     $rix'
      READ(*,*)
      EN = CHAR(48 + MOD(RY,88))
      OPEN(10,FILE = FNAME(1:4)//EN,ACCESS = 'DIRECT',RECL = 1)
      DO 20 N = 1,200
        MATRIX(N,367) = ' '
        L = 73200 + N
        WRITE(10,REC = L)MATRIX(N,367)
  20  CONTINUE
      NUM = 200*(REK-1)
      DO 30 M = 1,200
        MATRIX(M,REK) = TREC(M)
        J = NUM + M
        WRITE(10,REC = J)MATRIX(M,REK)
  30  CONTINUE
      CLOSE(10)
      RETURN
      END
***********************************************************************
      SUBROUTINE SPECYR(RD,RM,RY,NYD,REK,LY)
***********************************************************************
C     Determines whether record year is a leap year, the day of the
C     week of New Years day and the number of the record (1 - 365/366)

      INTEGER MTODL(12)
      INTEGER MTOD(12)
      INTEGER RD,RM,RY,LY,NYD,NYDCUM,L,Z,REK
      DATA MTOD / 0,31,59,90,120,151,181,212,243,273,304,334 /
      DATA MTODL / 0,31,60,91,121,152,182,213,244,274,305,335 /
 5    FORMAT(3I2)

C     The next lines test for a leap year

      L = (1900 + RY) - 1988
      IF(MOD(L,4).EQ.0)THEN
        LY = 1
```

```
C     Signifying a leap year

      ELSE
        LY = 2

C     Obviously not a leap year

      END IF

C     Now we find the day of the week of New Year's day (1 = mon)

      IF(MOD(L,4).EQ.0)THEN
        Z = 0
      ELSE IF(MOD(L,4).EQ.1)THEN
        Z = 2
      ELSE IF(MOD(L,4).EQ.2)THEN
        Z = 3
      ELSE
        Z = 4
      END IF
      NYDCUM = 5 + 5*INT(FLOAT(L)/4.0) + Z
      IF(MOD(NYDCUM,7).EQ.0)THEN
        NYD = 7
      ELSE
        NYD = MOD(NYDCUM,7)
      END IF

C     And now the number of the record in question

      IF(LY.EQ.1)THEN
        REK = MTODL(RM) + RD
      ELSE
        REK = MTOD(RM) + RD
      END IF
      RETURN
      END
************************************************************************
      SUBROUTINE MONREC(NYD,REK,RM,START,FDMON)
************************************************************************
C     Calculates START - the position (x) of 1st of the month

      INTEGER NYD,REK,FDMON,RM,START
      INTEGER*2 POSN(40)
      DATA POSN/30,31,32,33,34,36,37,39,40,41,42,43,45,46,48,49,50,51,
     $52,54,55,57,58,59,60,61,63,64,66,67,68,69,70,72,73,75,76,77,78,
     $79/

C     FDMON denotes the day of the week of 1st of the month (Mon = 1)

      J = MOD(REK,7) - 1
      FDMON = MOD((J + NYD),7)
      IF(FDMON.EQ.0)FDMON = 7
      IF(FDMON.EQ.1)THEN
        START = POSN(8)
      ELSE
        START = POSN(FDMON)
      END IF
      RETURN
```

```
      END
***********************************************************************
      SUBROUTINE MONNO(RM,RY)
***********************************************************************
C     Puts the month on the box created by BOXIT

      CHARACTER*3 MONTH(12)
      INTEGER RY,RM,YERE
      DATA MONTH/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP'
     $,'OCT','NOV','DEC'/
  10  FORMAT(1X,A)
  305 FORMAT(1X,I4)

      YERE = 1900 + RY
      CALL CURPOS(70,1)
      WRITE(*,305)YERE
      CALL CURPOS(53,3)
      WRITE(*,10)MONTH(RM)
      RETURN
      END
***********************************************************************
      SUBROUTINE DAYT(START,LY,RM,FDMON)
***********************************************************************
C     Puts the dates on the box drawn by BOXIT

      INTEGER MLEAP(12)
      INTEGER MNLEAP(12)
      INTEGER LY,RM,FDMON,FRST,START
      INTEGER*2 POSN(40)
      DATA POSN/30,31,32,33,34,36,37,39,40,41,42,43,45,46,48,49,50,51,5
     $2,54,55,57,58,59,60,61,63,64,66,67,68,69,70,72,73,75,76,77,78,79/
      DATA MLEAP/31,29,31,30,31,30,31,31,30,31,30,31/
      DATA MNLEAP/31,28,31,30,31,30,31,31,30,31,30,31/
  325 FORMAT(1X,I2)
  335 FORMAT(1X,I1)
   15 FORMAT(1X,A,I2)

      IF(FDMON.EQ.1)THEN
        J = 1
      ELSE
        J = 9 - FDMON
        CALL CURPOS(START,5)
        WRITE(*,335)1
      END IF
      L = 8
      DO 40 I = 1,5
        FRST = POSN(L)
        CALL CURPOS(FRST,5)
        IF(J.GE.10)THEN
          WRITE(*,325)J
        ELSE
          WRITE(*,335)J
        END IF
        L = L + 7
        J = J + 7
        IF(LY.EQ.1)THEN
          IF(J.GT.MLEAP(RM)) GOTO 60
        ELSE
```

```
        IF(J.GT.MNLEAP(RM)) GOTO 60
      END IF
 40   CONTINUE
 60   RETURN
      END
*************************************************************************
      SUBROUTINE DATAIN(FNAME,CNAME)
*************************************************************************
C     Requests basic information, viz, FNAME & CNAME

      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
 205  FORMAT(A,\)
 215  FORMAT(1X,A,\)

      CALL CLEAR
      CALL CURPOS(25,7)
      WRITE(*,215)'CONTRACT DATA'
      CALL CURPOS(20,12)
      WRITE(*,215)'FILE REFERENCE :'
      CALL CURPOS(48,12)
      WRITE(*,215)'(at least 4 characters)'
      CALL ATRIB(7)
      CALL CURPOS(38,12)
      WRITE(*,215)'      '
      CALL ATRIB(0)
      CALL CURPOS(20,18)
      WRITE(*,215)'CONTRACT NAME :'
      CALL ATRIB(7)
      CALL CURPOS(38,18)
      WRITE(*,215)'          '
      CALL CURPOS(38,12)
      READ(*,205)FNAME
      CALL CURPOS(38,18)
      READ(*,205)CNAME
      CALL ATRIB(0)
      RETURN
      END
*************************************************************************
      SUBROUTINE RECDTE(RM,RY)
*************************************************************************
C     Returns the record month and year to be displayed

      INTEGER RM,RY
 195  FORMAT(I2)
 205  FORMAT(1X,A,\)

      CALL CURPOS(25,7)
      WRITE(*,205)'RECORD DATA TO BE DISPLAYED'
      CALL CURPOS(20,12)
      WRITE(*,205)'RECORD YEAR : '
      CALL ATRIB(7)
      CALL CURPOS(34,12)
      WRITE(*,205)'  '
      CALL ATRIB(0)
      CALL CURPOS(20,18)
      WRITE(*,205)'RECORD MONTH : '
      CALL ATRIB(7)
```

```
      CALL CURPOS(34,18)
      WRITE(*,205)'  '
      CALL CURPOS(34,12)
      READ(*,195)RY
      CALL CURPOS(34,18)
      READ(*,195)RM
      CALL ATRIB(0)
      RETURN
      END
**********************************************************************
      SUBROUTINE DMENU(DPICK)
**********************************************************************
C     Puts the display menu on the screen

      INTEGER DPICK
  85  FORMAT(I1)
 185  FORMAT('             **********************',/'                REC
     $ORD-KEEPER',/'           **********************',/'
     $  DISPLAY MENU',/'          **********************',//' Please
     $select from the following:',//'  1)  DISPLAY MONTHly records',//
     $'  2)  DISPLAY YEAR''s records',//'  3)  RETURN, to the main menu
     $',///'   CHOICE ? :')

      WRITE(6,185)
      READ(*,85)DPICK
      RETURN
      END
**********************************************************************
      SUBROUTINE RDTREC(FNAME,REK,TREC,MATRIX,RY)
**********************************************************************
C     Reads current records for record date REK into TREC

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 MATRIX(MAX,367)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 EN
      INTEGER REK,RY

      EN = CHAR(48 + MOD(RY,88))
      OPEN(10,FILE = FNAME(1:4)//EN,ACCESS = 'DIRECT',RECL = 1)
      DO 40 N = 1,200
        MATRIX(N,367) = ' '
        L = 73200 + N
        WRITE(10,REC = L)MATRIX(N,367)
  40  CONTINUE
      NUM = 200*(REK - 1)
      DO 20 N = 1,200
        M = NUM + N
        READ(10,REC = M) MATRIX(N,REK)
        TREC(N) = MATRIX(N,REK)
  20  CONTINUE
      RETURN
      END
**********************************************************************
      SUBROUTINE BOXIT(CNAME)
**********************************************************************
C     Draws the main box for the program
```

```
      CHARACTER*10 CNAME
10    FORMAT(1X,A,\)

      CALL CLEAR
      CALL CURPOS(1,2)
      WRITE(*,10)CHAR(201)
      CALL CURPOS(1,24)
      WRITE(*,10)CHAR(200)
      DO 22 I = 2,79
        CALL CURPOS(I,2)
        WRITE(*,10)CHAR(205)
        CALL CURPOS(I,24)
        WRITE(*,10)CHAR(205)
        CALL CURPOS(I,6)
        WRITE(*,10)CHAR(196)
22    CONTINUE
      DO 24 K = 29,79
        CALL CURPOS(K,4)
        WRITE(*,10)CHAR(196)
24    CONTINUE
      CALL CURPOS(80,2)
      WRITE(*,10)CHAR(187)
      CALL CURPOS(80,24)
      WRITE(*,10)CHAR(188)
      DO 23 J = 3,23
        CALL CURPOS(1,J)
        WRITE(*,10)CHAR(186)
        CALL CURPOS(80,J)
        WRITE(*,10)CHAR(186)
        CALL CURPOS(8,J)
        WRITE(*,10)CHAR(179)
        CALL CURPOS(29,J)
        WRITE(*,10)CHAR(179)
 23   CONTINUE
      DO 26 L = 5,23
        CALL CURPOS(35,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(38,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(44,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(47,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(53,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(56,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(62,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(65,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(71,L)
        WRITE(*,10)CHAR(124)
        CALL CURPOS(74,L)
        WRITE(*,10)CHAR(124)
26    CONTINUE
      CALL CURPOS(8,2)
```

```
WRITE(*,10)CHAR(209)
CALL CURPOS(8,24)
WRITE(*,10)CHAR(207)
CALL CURPOS(8,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(29,2)
WRITE(*,10)CHAR(209)
CALL CURPOS(29,24)
WRITE(*,10)CHAR(207)
CALL CURPOS(29,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(1,6)
WRITE(*,10)CHAR(199)
CALL CURPOS(29,4)
WRITE(*,10)CHAR(195)
CALL CURPOS(80,4)
WRITE(*,10)CHAR(182)
CALL CURPOS(80,6)
WRITE(*,10)CHAR(182)
CALL CURPOS(35,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(35,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(38,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(38,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(44,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(44,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(47,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(47,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(53,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(53,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(56,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(56,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(62,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(62,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(65,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(65,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(71,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(71,6)
WRITE(*,10)CHAR(197)
CALL CURPOS(74,4)
WRITE(*,10)CHAR(194)
CALL CURPOS(74,6)
```

```
      WRITE(*,10)CHAR(197)
      CALL CURPOS(3,4)
      WRITE(*,10)'Code'
      CALL CURPOS(10,3)
      WRITE(*,10)'Activity'
      CALL CURPOS(10,5)
      WRITE(*,10)'Description'
      CALL CURPOS(3,25)
      WRITE(*,10)'F to end'
      CALL CURPOS(2,1)
      WRITE(*,10)CNAME
      RETURN
      END
**********************************************************************
      SUBROUTINE SCRDN(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS)
**********************************************************************
C     Scrolls the screen contents down 20 places through the file.

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      INTEGER INTS(MAX)
      INTEGER FPOS,FFPOS,LNUM,LPOS,AL
  25  FORMAT(T2,'Code',T9,'Activity Description',T33,'Input'/)
  35  FORMAT(T2,A4,T9,A18,T35,A1)
  45  FORMAT(1X,A,\)
      COMMON AL

      WRITE(*,25)
      J = 0
      FFPOS = FPOS + 1

C     Tests for last page of the file - if found, further calls simply
C     replace that last page.

      IF(FFPOS.GT.LPOS)THEN
        IF(MOD(LPOS,20).EQ.0)THEN
          FFPOS = LPOS - 19
          FPOS = FFPOS - 1
        ELSE
          FFPOS = LPOS - MOD(LPOS,20) + 1
          FPOS = FFPOS - 1
        END IF
      ELSE
        GOTO 20
      END IF

C      Ensures that only 20 lines are shown.

  20  IF(J.EQ.20)GOTO 30
      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')THEN
        GOTO 30
      ELSE
        J = J + 1
        FPOS = FPOS + 1
        WRITE(*,35)COD(INTS(FPOS)),DESC(INTS(FPOS)),TREC(INTS(FPOS))
        GOTO 20
```

```
   30  END IF

C      Positions the highlight on the first activity on the screen.

       CALL CURPOS(1,3)
       CALL ATRIB(7)
       WRITE(*,45)COD(INTS(FFPOS))
       CALL CURPOS(8,3)
       WRITE(*,45)DESC(INTS(FFPOS))
       CALL ATRIB(0)
       LNUM = 1
       RETURN
       END
**********************************************************************
       SUBROUTINE HIGHDN(COD,DESC,FPOS,FFPOS,LNUM,INTS)
**********************************************************************
C      Moves the cursor down one place in the file.

       PARAMETER(MAX = 200)
       CHARACTER*4 COD(MAX)
       CHARACTER*18 DESC(MAX)
       INTEGER INTS(MAX)
       INTEGER FPOS,FFPOS,LNUM,AL
   45  FORMAT(1X,A,\)
       COMMON AL

C      Tests for end of file or 20 values displayed.

       IF(COD(INTS(FFPOS + LNUM)).EQ.'XXXX'.OR.COD(INTS(FFPOS + LNUM))
      $.EQ.'xxxx'.OR.LNUM.EQ.20)THEN
         GOTO 10
       ELSE

C      Turns highlight off for current activity, on for next

         FPOS = FFPOS + LNUM
         CALL CURPOS(1,LNUM+2)
         CALL ATRIB(0)
         WRITE(*,45)COD(INTS(FPOS - 1))
         CALL CURPOS(8,LNUM+2)
         WRITE(*,45)DESC(INTS(FPOS - 1))
         CALL CURPOS(1,LNUM+3)
         CALL ATRIB(7)
         WRITE(*,45)COD(INTS(FPOS))
         CALL CURPOS(8,LNUM+3)
         WRITE(*,45)DESC(INTS(FPOS))
         CALL ATRIB(0)
         LNUM = LNUM+1
    10 END IF
       RETURN
       END
**********************************************************************
       SUBROUTINE SCRUP(COD,DESC,FPOS,FFPOS,LNUM,LPOS,TREC,INTS)
**********************************************************************
C      Scrolls the screen contents up 20 places through the file.

       PARAMETER(MAX = 200)
       CHARACTER*4 COD(MAX)
```

```
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 TREC(MAX)
      INTEGER INTS(MAX)
      INTEGER FPOS,FFPOS,LNUM,LPOS,AL
   25 FORMAT(T2,'Code',T9,'Activity Description',T33,'Input'/)
   35 FORMAT(T2,A4,T9,A18,T35,A1)
   45 FORMAT(1X,A,\)
      COMMON AL
C     Tests for the current position in the file

      IF(MOD(FPOS,20).EQ.0)THEN
        FPOS = FPOS - 40
      ELSE IF(FPOS.LT.20)THEN
        FPOS = O
      ELSE
        FPOS = FPOS - (20 + MOD(FPOS,20))
      END IF
      IF(FPOS.EQ.-20)FPOS = 0

C     Writes up 20 lines of the file

      FFPOS = FPOS + 1
      WRITE(*,25)
      K = 0
   40 IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx'.OR.K
     $.EQ.20)THEN
        GOTO 50
      ELSE
        K = K + 1
        FPOS = FPOS + 1
        WRITE(*,35)COD(INTS(FPOS)),DESC(INTS(FPOS)),TREC(INTS(FPOS))
        GOTO 40
   50 END IF

C     Positions the highlight on the first activity on the screen.

      CALL CURPOS(1,3)
      CALL ATRIB(7)
      WRITE(*,45)COD(INTS(FFPOS))
      CALL CURPOS(8,3)
      WRITE(*,45)DESC(INTS(FFPOS))
      CALL ATRIB(0)
      LNUM = 1
      RETURN
      END
*********************************************************************
      SUBROUTINE HIGHUP(COD,DESC,FPOS,FFPOS,LNUM,INTS)
*********************************************************************
C     Moves the cursor up one place in the file.

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER INTS(MAX)
      INTEGER FPOS,FFPOS,LNUM,AL
   45 FORMAT(1X,A,\)
      COMMON AL
```

```
      IF(LNUM.EQ.1)THEN
        GOTO 20
      ELSE

C     Turns highlight off for current activity, on for previous

        FPOS = FFPOS + LNUM - 2
        CALL CURPOS(1,LNUM+2)
        CALL ATRIB(0)
        WRITE(*,45)COD(INTS(FPOS + 1))
        CALL CURPOS(8,LNUM+2)
        WRITE(*,45)DESC(INTS(FPOS + 1))
        CALL ATRIB(7)
        CALL CURPOS(1,LNUM+1)
        WRITE(*,45)COD(INTS(FPOS))
        CALL CURPOS(8,LNUM+1)
        WRITE(*,45)DESC(INTS(FPOS))
        CALL ATRIB(0)
        LNUM = LNUM-1
      END IF
   20 RETURN
      END
***********************************************************************
      SUBROUTINE GETYR(RY)
***********************************************************************
C     Requests year of records to be displayed

      INTEGER RY
  125 FORMAT(1X,A,\)
  135 FORMAT(I2)

      CALL CURPOS(10,12)
      WRITE(*,125)'Which year''s records do you want to display ? 19'
      CALL ATRIB(7)
      CALL CURPOS(58,12)
      WRITE(*,125)'  '
      CALL CURPOS(58,12)
      READ(*,135)RY
      CALL ATRIB(0)
      RETURN
      END
***********************************************************************
      SUBROUTINE YRBOX(RY,CNAME)
***********************************************************************
C     Draws the box to display a year's records

      CHARACTER*10 CNAME
      INTEGER RY,YY
   15 FORMAT(1X,A,\)
   25 FORMAT(1X,I4)

      CALL CLEAR
      DO 20 I = 5,76
        CALL CURPOS(I,2)
        WRITE(*,15)CHAR(205)
        CALL CURPOS(I,6)
        WRITE(*,15)CHAR(196)
        CALL CURPOS(I,24)
```

```
        WRITE(*,15)CHAR(205)
 20   CONTINUE
      DO 30 J = 12,76
        CALL CURPOS(J,4)
        WRITE(*,15)CHAR(196)
 30   CONTINUE
      DO 40 K = 3,23
        CALL CURPOS(4,K)
        WRITE(*,15)CHAR(186)
        CALL CURPOS(11,K)
        WRITE(*,15)CHAR(179)
        CALL CURPOS(77,K)
        WRITE(*,15)CHAR(186)
 40   CONTINUE
      DO 50 L = 5,23
        CALL CURPOS(22,L)
        WRITE(*,15)CHAR(124)
        CALL CURPOS(33,L)
        WRITE(*,15)CHAR(124)
        CALL CURPOS(44,L)
        WRITE(*,15)CHAR(124)
        CALL CURPOS(55,L)
        WRITE(*,15)CHAR(124)
        CALL CURPOS(66,L)
        WRITE(*,15)CHAR(124)
50    CONTINUE
      CALL CURPOS(11,2)
      WRITE(*,15)CHAR(209)
      CALL CURPOS(11,24)
      WRITE(*,15)CHAR(207)
      CALL CURPOS(4,2)
      WRITE(*,15)CHAR(201)
      CALL CURPOS(4,6)
      WRITE(*,15)CHAR(199)
      CALL CURPOS(4,24)
      WRITE(*,15)CHAR(200)
      CALL CURPOS(77,2)
      WRITE(*,15)CHAR(187)
      CALL CURPOS(77,4)
      WRITE(*,15)CHAR(182)
      CALL CURPOS(77,6)
      WRITE(*,15)CHAR(182)
      CALL CURPOS(77,24)
      WRITE(*,15)CHAR(188)
      CALL CURPOS(11,4)
      WRITE(*,15)CHAR(195)
      CALL CURPOS(11,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(22,4)
      WRITE(*,15)CHAR(194)
      CALL CURPOS(33,4)
      WRITE(*,15)CHAR(194)
      CALL CURPOS(44,4)
      WRITE(*,15)CHAR(194)
      CALL CURPOS(55,4)
      WRITE(*,15)CHAR(194)
      CALL CURPOS(66,4)
      WRITE(*,15)CHAR(194)
```

```
      CALL CURPOS(22,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(33,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(44,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(55,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(66,6)
      WRITE(*,15)CHAR(197)
      CALL CURPOS(4,1)
      WRITE(*,15)CNAME
      YY = 1900 + RY
      CALL CURPOS(42,1)
      WRITE(*,25)YY
      CALL CURPOS(12,3)
      WRITE(*,15)'jan  feb  mar  apr  may  jun  jul  aug  sep  oct  nov
     $ dec'
      CALL CURPOS(12,5)
      WRITE(*,15)'1'
      CALL CURPOS(23,5)
      WRITE(*,15)'11'
      CALL CURPOS(34,5)
      WRITE(*,15)'21'
      CALL CURPOS(45,5)
      WRITE(*,15)'31'
      CALL CURPOS(56,5)
      WRITE(*,15)'41'
      CALL CURPOS(67,5)
      WRITE(*,15)'51'
      CALL CURPOS(6,4)
      WRITE(*,15)'Code'
      CALL CURPOS(3,25)
      WRITE(*,15)'F to end'
      RETURN
      END
************************************************************************
      SUBROUTINE WATWK(NYD,RY,REK,WKNO)
************************************************************************
C     Calculates from REK, the week no. WKNO of a particular record

      INTEGER NYD,RY,REK,WKNO

      LL = 8 - NYD
      J = (366 - LL)/7
      K = LL + J*7 + 1
      IF(REK.LE.LL)THEN
        WKNO = 1
      ELSE IF(REK.GE.K)THEN
        WKNO = J + 2
      ELSE
        WKNO = (REK - LL - 1)/7 + 2
      END IF
      RETURN
      END
```

```
************************************************************************
      SUBROUTINE RITEWK(FNAME,WKNO,TREC,WKDAT,RY)
************************************************************************
C     Writes to the matrix WKDAT, at position WKNO for those activities
C     identified by TREC as having activities working.

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 WKDAT(MAX,55)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 EN
      INTEGER WKNO,RY
  15  FORMAT(1X,A,I6)
  25  FORMAT(1X,A)

      EN = CHAR(48 + MOD(RY,88))
      OPEN(11,FILE = FNAME(1:3)//'X'//EN,ACCESS = 'DIRECT',RECL = 1)
      DO 10 N = 1,MAX
        WKDAT(N,55) = ' '
        L = 10800 + N
        WRITE(11,REC = L)WKDAT(N,55)
  10  CONTINUE
      DO 20 J = 1,MAX
        IF(TREC(J).EQ.'X'.OR.TREC(J).EQ.'H'.OR.TREC(J).EQ.'W'.OR.TREC(J
     $  ).EQ.'R'.OR.TREC(J).EQ.'x'.OR.TREC(J).EQ.'h'.OR.TREC(J).EQ.'w'
     $  .OR.TREC(J).EQ.'r'.OR.TREC(J).EQ.'D'.OR.TREC(J).EQ.'d')THEN
          M = (WKNO - 1)*MAX + J
          WRITE(11,REC = M)CHAR(178)
        ELSE
          CONTINUE
        END IF
   20 CONTINUE
      RETURN
      END
************************************************************************
      SUBROUTINE ENDIN(FNAME,TREC,LPOS,YESNO,RD,RM,RY,WKDAT,WKNO,INTS
     $,INTT,INTU,INTUNO)
************************************************************************
C     Checks to make sure that the user wishes to end the input session
C     and then writes TREC to a file in stream 8 called FNAME(4)TF

      PARAMETER (MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*10 CNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*1 MATRIX(200,367)
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*1 WKDAT(MAX,55)
      INTEGER INTS(MAX)
      INTEGER INTT(MAX)
      INTEGER INTU(MAX)
      INTEGER FPOS,LPOS,FFPOS,RD,RM,RY,REK,LNUM,NYD,PICK
      INTEGER INPICK,ORDR,WKNO,INTUNO
    5 FORMAT(3I2)
  125 FORMAT(A,\)
  145 FORMAT(1X,A1)
```

```
      CALL CURPOS(16,12)
      WRITE(*,125)' Do you want to end the input session (Y/N)?'
      READ(*,125)YESNO
      IF(YESNO.EQ.'Y'.OR.YESNO.EQ.'y')THEN
        OPEN(8,FILE = FNAME(1:4)//'TF')
        REWIND 8
        WRITE(8,5)RD,RM,RY
        DO 30 J = 1,LPOS
          WRITE(8,145)TREC(INTS(J))
   30   CONTINUE
        CLOSE(8)
      ELSE
        CALL CLEAR
        CONTINUE
      END IF
      RETURN
      END
***********************************************************************
      SUBROUTINE INPUT4(LNUM,FPOS,TREC,LPOS,FFPOS,INTS,COD)
***********************************************************************
C     Writes activity progress selections to screen and to TREC

      PARAMETER(MAX = 200)
      CHARACTER*4 COD(MAX)
      CHARACTER*1 TREC(MAX)
      INTEGER INTS(MAX)
      INTEGER LNUM,FPOS,FFPOS,LPOS,AL
  125 FORMAT(1X,A1,\)
      COMMON AL


C     Checks if SCRDN/SCRUP has just been called and if so ensures
C     that input is directed to FFPOS;(SCR** leave FPOS as last value
C     on the screen although first value is highlighted).

      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')
     $GOTO 20
      TREC(INTS(FPOS)) = CHAR(AL)
      CALL CURPOS(34,LNUM + 2)
      WRITE(*,125)CHAR(AL)
   20 RETURN
      END
***********************************************************************
      SUBROUTINE INPUT1(FNAME,COD,DESC,INTS)
***********************************************************************
C     Allows activity codes and descriptions to be input

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER INTS(MAX)
   25 FORMAT(A4)
  225 FORMAT(1X,A4)
   35 FORMAT(T2,A4,T9,A18)
   45 FORMAT(A18)
  245 FORMAT(1X,A18)
  125 FORMAT(1X,A,\)
```

```
C     Writes up instructions

      CALL CURPOS(5,1)
      WRITE(*,125)'CODE'
      CALL CURPOS(11,1)
      WRITE(*,125)'ACTIVITY DESCRIPTION'
      CALL CURPOS(35,8)
      WRITE(*,125)'Give details of activity codes'
      CALL CURPOS(35,10)
      WRITE(*,125)'and descriptions'
      CALL CURPOS(35,14)
      WRITE(*,125)'When no more activities are to be'
      CALL CURPOS(35,16)
      WRITE(*,125)'recorded, type ''XXXX'' against CODE'
      CALL CURPOS(35,18)
      WRITE(*,125)'and ''XXXX'' against DESCRIPTION'
      OPEN(9,FILE=FNAME)
      I = 1

C     Writes up input positions for first activity

      CALL ATRIB(7)
      CALL CURPOS(5,3)
      WRITE(*,125)'    '
      CALL CURPOS(11,3)
      WRITE(*,125)'                    '
      CALL CURPOS(5,3)
      READ(*,25)COD(INTS(I))
      CALL CURPOS(11,3)
      READ(*,45)DESC(INTS(I))
      WRITE(9,35)COD(INTS(I)),DESC(INTS(I))
      CALL ATRIB(0)
      LN = 3
   30 IF(LN.LT.24)THEN

C     Deals with input of 2nd to 22nd activities

        IF(COD(INTS(I)).EQ.'XXXX'.OR.COD(INTS(I)).EQ.'xxxx'.OR.I.EQ.
     $  MAX)THEN
          CLOSE(9)
        ELSE
          CALL CURPOS(5,LN)
          WRITE(*,225)COD(INTS(I))
          CALL CURPOS(9,LN)
          WRITE(*,125)'  '
          CALL CURPOS(11,LN)
          WRITE(*,245)DESC(INTS(I))
          I = I + 1
          LN = LN + 1
          CALL ATRIB(7)
          CALL CURPOS(5,LN)
          WRITE(*,125)'    '
          CALL CURPOS(11,LN)
          WRITE(*,125)'                    '
          CALL CURPOS(5,LN)
          READ(*,25)COD(INTS(I))
          CALL CURPOS(11,LN)
          READ(*,45)DESC(INTS(I))
```

```
          WRITE(9,35)COD(INTS(I)),DESC(INTS(I))
          CALL ATRIB(0)
          GOTO 30
        END IF
      ELSE

C     Refreshes page for all activities after 22nd

 40     IF(COD(INTS(I)).EQ.'XXXX'.OR.COD(INTS(I)).EQ.'xxxx'.OR.I.EQ.
     $  MAX)THEN
          CLOSE(9)
        ELSE
          J = I - 20
          DO 50 K = 0,20
            CALL CURPOS(5,K+3)
            WRITE(*,225)COD(INTS(J+K))
            CALL CURPOS(11,K+3)
            WRITE(*,245)DESC(INTS(J+K))
 50       CONTINUE
          I = I + 1
          CALL ATRIB(7)
          CALL CURPOS(5,24)
          WRITE(*,125)'    '
          CALL CURPOS(11,24)
          WRITE(*,125)'                  '
          CALL CURPOS(5,24)
          READ(*,25)COD(INTS(I))
          CALL CURPOS(11,24)
          READ(*,45)DESC(INTS(I))
          WRITE(9,35)COD(INTS(I)),DESC(INTS(I))
          CALL ATRIB(0)
          GOTO 40
        END IF
      END IF
      CALL ATRIB(0)
      RETURN
      END
***********************************************************************
      SUBROUTINE DISPLY(FNAME,CNAME,COD,DESC,MATRIX,RD,RM,RY,FREK,REK,
     $LY,FDMON,NYD,DPICK,FRPOS,START,FPOS,LPOS,TREC,YESNO,FFPOS,LNUM,
     $PICK,INPICK,ORDR,WKDAT,WKNO,ST,INTS)
***********************************************************************
C     Displays RM's records for the year 19RY in the box created
C     by BOXIT

      PARAMETER(MAX=200)
      CHARACTER*2 YEND(12)
      CHARACTER*4 YERE
      CHARACTER*1 EN
      CHARACTER*1 TREC(MAX)
      CHARACTER*1 YESNO
      CHARACTER*3 MONTH(12)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*10 CNAME
      CHARACTER*6 FNAME
      CHARACTER*1 MATRIX(MAX,367)
      CHARACTER*1 WKDAT(MAX,55)
```

```
      INTEGER RD,RM,RY,FREK,REK,FDMON,LY,NYD,NYDCUM,DPICK,XXX,YYY,WKNO
      INTEGER FPOS,LPOS,FFPOS,LNUM,PICK,INPICK,ORDR,FRPOS,START,FRST,ST
      INTEGER MTOD(12)
      INTEGER MTODL(12)
      INTEGER INTS(MAX)
      INTEGER*2 POSN(40)
      INTEGER*4 K
      LOGICAL DOSIT
      INCLUDE 'SYSREG'
      COMMON AL
      DATA POSN/30,31,32,33,34,36,37,39,40,41,42,43,45,46,48,49,50,51,5
     $2,54,55,57,58,59,60,61,63,64,66,67,68,69,70,72,73,75,76,77,78,79/
  315 FORMAT(1X,A)

      ST = 2
      RD = 1
      FPOS = 0
      CALL CLEAR
      CALL RECDTE(RM,RY)
      EN = CHAR(48 + MOD(RY,88))
      INQUIRE(FILE = FNAME(1:4)//EN,EXIST = DOSIT)
      IF(DOSIT)THEN
        CONTINUE
      ELSE
        CALL CLEAR
        CALL CURPOS(10,12)
        WRITE(*,315)'NO RECORDS HELD FOR THIS YEAR: PRESS A KEY'
        READ(*,*)
        GOTO 20
      END IF
      CALL CLEAR
      CALL SPECYR(RD,RM,RY,NYD,REK,LY)
      CALL BOXIT(CNAME)
      CALL MONREC(NYD,REK,RM,START,FDMON)
      CALL DAYT(START,LY,RM,FDMON)
      CALL MONNO(RM,RY)
      CALL ACTMDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
      DO 10 I = 1,1000
        AH = $07
        CALL SYS1(SYSREG)
        IF(AL.EQ.$5B)THEN
          CALL ACTMDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
        ELSE IF(AL.EQ.$5D)THEN
          CALL ACTMUP(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
        ELSE IF(AL.EQ.$44.OR.AL.EQ.$64)THEN
          CALL MRECS(FNAME,MATRIX,COD,DESC,RY,RM,FREK,FRPOS,LY
     $      ,FDMON,REK,FPOS,LPOS,ST,INTS)
        ELSE IF(AL.EQ.$46.OR.AL.EQ.$66)THEN
          GOTO 20
        ELSE
          CONTINUE
        END IF
   10 CONTINUE
   20 RETURN
      END
```

```
***********************************************************************
      SUBROUTINE ACTMDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
***********************************************************************
C     Scrolls down COD and DESC for monthly displays

      PARAMETER(MAX=200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER LPOS,FPOS,FFPOS,ST
      INTEGER INTS(MAX)
  315 FORMAT(1X,A)

      J = 7
      FFPOS = FPOS + 1
      IF(FFPOS.GT.LPOS)GOTO 80

C     Indicates that activities and records are out of synch

      IF(FPOS.EQ.(ST-1))THEN
        CALL CURPOS(32,3)
        WRITE(*,315)'          '
        CALL CURPOS(66,3)
        WRITE(*,315)'           '
      ELSE
        CALL CURPOS(32,3)
        WRITE(*,315)'**FALSE**'
        CALL CURPOS(66,3)
        WRITE(*,315)'**RECORDS**'
      END IF

C     Tests for last page of the file - if found, further calls cause
C     no action

   20 IF(J.EQ.22) GOTO 80
      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')THEN
        J = J + 1
        CALL CURPOS(3,J)
        WRITE(*,315)'    '
        CALL CURPOS(10,J)
        WRITE(*,315)'                  '
        GOTO 20
      ELSE
        FPOS = FPOS + 1
        J = J + 1
        CALL CURPOS(3,J)
        WRITE(*,315)COD(INTS(FPOS))
        CALL CURPOS(10,J)
        WRITE(*,315)DESC(INTS(FPOS))
        GOTO 20
      END IF
   80 RETURN
      END
***********************************************************************
      SUBROUTINE ACTMUP(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
***********************************************************************
C     Scrolls up COD and DESC for monthly displays

      PARAMETER(MAX=200)
```

```
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER LPOS,FPOS,FFPOS,ST
      INTEGER INTS(MAX)
  315 FORMAT(1X,A)

C     Tests for the current position in the file

      IF(FPOS.LE.15)THEN
        FPOS = 0
      ELSE IF(MOD(FPOS,15).EQ.0)THEN
        FPOS = FPOS - 30
      ELSE
        FPOS = FPOS - (15 + MOD(FPOS,15))
      END IF

C     Indicates that activities and records are out of synch

      IF(FPOS.EQ.(ST-1))THEN
        CALL CURPOS(32,3)
        WRITE(*,315)'           '
        CALL CURPOS(66,3)
        WRITE(*,315)'             '
      ELSE
        CALL CURPOS(32,3)
        WRITE(*,315)'**FALSE**'
        CALL CURPOS(66,3)
        WRITE(*,315)'**RECORDS**'
      END IF

C     Writes up 15 lines of the file

      J = 7
 20   IF(J.EQ.22.OR.COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.
     $'xxxx')THEN
        GOTO 80
      ELSE
        FPOS = FPOS + 1
        J = J + 1
        CALL CURPOS(3,J)
        WRITE(*,315)COD(INTS(FPOS))
        CALL CURPOS(10,J)
        WRITE(*,315)DESC(INTS(FPOS))
        GOTO 20
      END IF
  80  RETURN
      END
***********************************************************************
      SUBROUTINE MRECS(FNAME,MATRIX,COD,DESC,RY,RM,FREK,FRPOS,LY
     $,FDMON,REK,FPOS,LPOS,ST,INTS)
***********************************************************************
C     Displays RM's records for the year 19RY in the box created
C     by BOXIT

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 MATRIX(MAX,367)
      CHARACTER*18 DESC(MAX)
```

```
      CHARACTER*4 COD(MAX)
      CHARACTER*1 EN
      INTEGER RY,RM,FREK,JJ,LY,FDMON,REK,FRPOS,XXX,YYY,ST,FN,FPOS,LPOS
      INTEGER*2 POSN(40)
      INTEGER INTS(MAX)
      INTEGER*4 K
  315 FORMAT(1X,A,\)
  22  FORMAT(1X,A,I5)
  35  FORMAT (1X,I6)
      DATA POSN/30,31,32,33,34,36,37,39,40,41,42,43,45,46,48,49,50,51,5
     $2,54,55,57,58,59,60,61,63,64,66,67,68,69,70,72,73,75,76,77,78,79/

      M = MOD(RY,88)
      EN = CHAR(48 + M )
      OPEN(9,FILE = FNAME(1:4)//EN,ACCESS = 'DIRECT',RECL = 1)

C     Calculates FREK - the number of the first record displayed
C                FRPOS - the position (x) of the 1st of the month
C                JJ - the number of records to be displayed

      JJ = 40
      IF(RM.EQ.1)THEN
        IF(FDMON.EQ.1)THEN
          JJ = 33
          FREK = 1
          FRPOS = 8
        ELSE
          JJ = 41 - FDMON
          FREK = 1
          FRPOS = FDMON
        END IF
      ELSE
        IF(FDMON.EQ.1)THEN
          FREK = REK - 7
          FRPOS = 1
        ELSE
          L = FDMON - 1
          FREK = REK - L
          FRPOS = 1
        END IF
      END IF
      IF(RM.EQ.12)THEN
        IF(LY.EQ.1)THEN
          JJ = 367 - FREK
        ELSE
          JJ = 366 - FREK
        END IF
      ELSE
        CONTINUE
      END IF

C     Determines how many activities' records need to be shown

      IF(FPOS.EQ.LPOS)THEN
        ST = LPOS - (MOD(LPOS,15) - 1)
        FN = LPOS - 1
      ELSE
        ST = FPOS - 14
```

```
        FN = FPOS
      END IF

C     And now puts those records on the screen

      CALL CURPOS(32,3)
      WRITE(*,315)'        '
      CALL CURPOS(66,3)
      WRITE(*,315)'          '
      YYY = 7
      DO 20 I = ST,FN
        YYY = YYY + 1
        DO 40 J = 1,JJ
          N = FREK + J - 1
          K = (N - 1)*200 + INTS(I)
          L = FRPOS + J - 1
          XXX = POSN(L)
          READ(9,REC = K)MATRIX(INTS(I),N)
          CALL CURPOS(XXX,YYY)
          WRITE(*,315)MATRIX(INTS(I),N)
 40     CONTINUE
 20   CONTINUE
      CLOSE(9)

C     Clears the screen of records beyond the end of the activity list

      LLL = FN - ST
      IF(LLL.NE.14)THEN
        NULS = 14 - LLL
        YYY = 22 - NULS
        DO 30 NN = 1,NULS
          YYY = YYY + 1
          DO 50 J = 1,JJ
            L = FRPOS + J - 1
            XXX = POSN(L)
            CALL CURPOS(XXX,YYY)
            WRITE(*,315)' '
 50       CONTINUE
 30     CONTINUE
      ELSE
        CONTINUE
      END IF
      RETURN
      END
************************************************************************
      SUBROUTINE DISPYR(FNAME,CNAME,COD,DESC,RY,FPOS,LPOS,FFPOS,LNUM,
     $WKDAT,WKNO,ST,INTS)
************************************************************************
C     Displays the records for the year 19RY in the box created
C     by YRBOX

      PARAMETER(MAX=200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      CHARACTER*10 CNAME
      CHARACTER*6 FNAME
      CHARACTER*1 WKDAT(MAX,55)
      CHARACTER*1 EN
```

```
      INTEGER RY,XXX,YYY,WKNO
      INTEGER FPOS,LPOS,FFPOS,LNUM,ST
      INTEGER INTS(MAX)
      INTEGER*4 K
      LOGICAL DOSIT
      INCLUDE 'SYSREG'
      COMMON AL
  315 FORMAT(1X,A)

      ST = 2
      FPOS = 0
      CALL CLEAR
      CALL RDFIL1(FNAME,COD,DESC,LPOS,INTS)
      CALL GETYR(RY)
      EN = CHAR(48 + MOD(RY,88))
      INQUIRE(FILE = FNAME(1:3)//'X'//EN,EXIST = DOSIT)
      IF(DOSIT)THEN
        CONTINUE
      ELSE
        CALL CLEAR
        CALL CURPOS(10,12)
        WRITE(*,315)'NO RECORDS HELD FOR THIS YEAR: PRESS A KEY'
        READ(*,*)
        GOTO 20
      END IF
      CALL CLEAR
      CALL YRBOX(RY,CNAME)
      CALL ACTYDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
      DO 10 I = 1,1000
        AH = $07
        CALL SYS1(SYSREG)
        IF(AL.EQ.$5B)THEN
          CALL ACTYDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
        ELSE IF(AL.EQ.$5D)THEN
          CALL ACTYUP(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
        ELSE IF(AL.EQ.$44.OR.AL.EQ.$64)THEN
          CALL YRECS(FNAME,WKDAT,COD,DESC,RY,FPOS,LPOS,ST)
        ELSE IF(AL.EQ.$46.OR.AL.EQ.$66)THEN
          GOTO 20
        ELSE
          CONTINUE
        END IF
   10 CONTINUE
   20 RETURN
      END
**********************************************************************
      SUBROUTINE ACTYDN(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
**********************************************************************
C     Scrolls down COD for year's displays

      PARAMETER(MAX=200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER LPOS,FPOS,FFPOS,ST
      INTEGER INTS(MAX)
  315 FORMAT(1X,A)

      J = 7
```

```
      FFPOS = FPOS + 1
      IF(FFPOS.GT.LPOS)GOTO 80

C     Indicates that activities and records are out of synch

      IF(FPOS.EQ.(ST-1))THEN
        CALL CURPOS(23,7)
        WRITE(*,315)'          '
        CALL CURPOS(34,7)
        WRITE(*,315)'          '
      ELSE
        CALL CURPOS(23,7)
        WRITE(*,315)'**FALSE***'
        CALL CURPOS(34,7)
        WRITE(*,315)'*RECORDS**'
      END IF

C     Tests for last page of the file - if found, further calls cause
C     no action

   20 IF(J.EQ.22) GOTO 80
      IF(COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.'xxxx')THEN
        J = J + 1
        CALL CURPOS(6,J)
        WRITE(*,315)'    '
        GOTO 20
      ELSE
        FPOS = FPOS + 1
        J = J + 1
        CALL CURPOS(6,J)
        WRITE(*,315)COD(INTS(FPOS))
        GOTO 20
      END IF
   80 RETURN
      END
***********************************************************************
      SUBROUTINE ACTYUP(COD,DESC,LPOS,FPOS,FFPOS,ST,INTS)
***********************************************************************
C     Scrolls up COD for yearly displays

      PARAMETER(MAX=200)
      CHARACTER*4 COD(MAX)
      CHARACTER*18 DESC(MAX)
      INTEGER LPOS,FPOS,FFPOS,ST
      INTEGER INTS(MAX)
  315 FORMAT(1X,A)

C     Tests for the current position in the file

      IF(FPOS.LE.15)THEN
        FPOS = 0
      ELSE IF(MOD(FPOS,15).EQ.0)THEN
        FPOS = FPOS - 30
      ELSE
        FPOS = FPOS - (15 + MOD(FPOS,15))
      END IF

C     Indicates that activities and records are out of synch
```

```
      IF(FPOS.EQ.(ST-1))THEN
        CALL CURPOS(23,7)
        WRITE(*,315)'          '
        CALL CURPOS(34,7)
        WRITE(*,315)'          '
      ELSE
        CALL CURPOS(23,7)
        WRITE(*,315)'**FALSE***'
        CALL CURPOS(34,7)
        WRITE(*,315)'*RECORDS**'
      END IF

C     Writes up 15 lines of the file

      J = 7
 20   IF(J.EQ.22.OR.COD(INTS(FPOS)).EQ.'XXXX'.OR.COD(INTS(FPOS)).EQ.
     $'xxxx')THEN
        GOTO 80
      ELSE
        FPOS = FPOS + 1
        J = J + 1
        CALL CURPOS(6,J)
        WRITE(*,315)COD(INTS(FPOS))
        GOTO 20
      END IF
 80   RETURN
      END
***********************************************************************
      SUBROUTINE YRECS(FNAME,WKDAT,COD,DESC,RY,FPOS,LPOS,ST)
***********************************************************************
C     Displays the records for the year 19RY in the box created
C     by YRBOX

      PARAMETER(MAX=200)
      CHARACTER*6 FNAME
      CHARACTER*1 WKDAT(MAX,55)
      CHARACTER*18 DESC(MAX)
      CHARACTER*4 COD(MAX)
      CHARACTER*1 EN
      INTEGER RY,XXX,YYY,ST,FN,FPOS,LPOS
      INTEGER*4 K
 315  FORMAT(1X,A,\)

      M = MOD(RY,88)
      EN = CHAR(48 + M )
      OPEN(11,FILE = FNAME(1:3)//'X'//EN,ACCESS = 'DIRECT',RECL = 1)

C     Determines how many activities' records need to be shown

      IF(FPOS.EQ.LPOS)THEN
        ST = LPOS - (MOD(LPOS,15) - 1)
        FN = LPOS - 1
      ELSE
        ST = FPOS - 14
        FN = FPOS
      END IF

C     And now puts those records on the screen
```

```
      CALL CURPOS(23,7)
      WRITE(*,315)'          '
      CALL CURPOS(34,7)
      WRITE(*,315)'          '
      YYY = 7
      DO 20 I = ST,FN
        YYY = YYY + 1
        DO 40 J = 1,55
          L = (J-1)*MAX + I
          READ(11,REC=L)WKDAT(I,J)
          XXX = J + 11 + (J-1)/10
          CALL CURPOS(XXX,YYY)
          WRITE(*,315)WKDAT(I,J)
 40     CONTINUE
 20   CONTINUE
      CLOSE(9)

C     Clears the screen of records beyond the end of the activity list

      LLL = FN - ST
      IF(LLL.NE.14)THEN
        NULS = 14 - LLL
        YYY = 22 - NULS
        DO 30 NN = 1,NULS
          YYY = YYY + 1
          DO 50 J = 1,55
            XXX = J + 11 + (J-1)/10
            CALL CURPOS(XXX,YYY)
            WRITE(*,315)' '
 50       CONTINUE
 30     CONTINUE
      ELSE
        CONTINUE
      END IF
      RETURN
      END
```

APPENDIX 5

PILOT QUESTIONNAIRE: AMENDED QUESTIONS

PILOT QUESTIONNAIRE: AMENDED QUESTIONS

A number of amendments were made to the initial questionnaires following the pilot study. These changes are discussed in chapter 4, and the original versions of these amended questions are reproduced here.

ENGINEER'S QUESTIONNAIRE

Q10 In carrying out this check, how concerned are you with the following?

	RATING	COMMENT
* number of activities		
* level of activity		
* sequence of activities		
* duration of activities		
* agreement with specified details in the contract		
* practicality of the plan		
* combined activities		
* resource implications		

RATING:		
	very concerned	1
	fairly concerned	2
	not concerned	3

Q13 If so, how are these viewed?

Q23 Of the extension of time claims submitted with supporting evidence, how often are these granted...

* in full
* in part
* with overhead costs
* without overhead costs

Q24 How accurate is this information?

* very accurate
* fairly accurate
* an impression only

Q27 How accurate is this information?

* very accurate
* fairly accurate
* an impression only

The following statements represent commonly held views on the subject of extension of time and acceleration claims. Please indicate whether you agree or disagree with the views:

	agree/disagree	comment
Q28 There is no point in making a claim for an extension of time unless the contract period has been exceeded and liquidated damages would otherwise be deducted		
Q29 If the contract programme (clause 14) showed completion in 18 months and the Contractor actually completed in 18 months, no extension of time claim can be justified.		
Q30 If the Engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the Contractor from claiming an extension of time with recovery of overhead costs.		
Q31 Providing the Engineer never actually instructs the Contractor to accelerate, then no acceleration claim can be justified.		

Q44 What importance do you attach to the initial critical path (if one is shown)?

* great importance
* some importance
* little importance

Q9 If so, do you consider these activities to be scheduled as taking place at a particular time or perhaps as occurring following certain other activities in the programme?

Q12 What use is made of the contract programme during and following the construction process?

Q13 Please indicate your views on the importance of the following aspects of the contract programme by ranking them in order, viz, 1 = most important, 3 = least important.

	ranking	comment
* The programme provides an agreed plan against which actual progress may be measured, compared and adjusted if necessary.		
* The programme states the Contractor's intended method of working, which can then be agreed as acceptable by the Engineer.		
* The programme is the agreed basis against which the effects of delay to the project may be determined.		

Q16 Of the extension of time claims submitted with supporting evidence, how often are these granted...

* in full
* in part
* with overhead costs
* without overhead costs

Q17 How accurate is this information?

* very accurate
* fairly accurate
* an impression only

Q20 How accurate is this information?

* very accurate
* fairly accurate
* an impression only

The following statements represent commonly held views on the subject of extension of time and acceleration claims. Please indicate whether you agree or disagree with the views:

	agree/disagree	comment
Q21 There is no point in making a claim for an extension of time unless the contract period has been exceeded and liquidated damages would otherwise be deducted		
Q22 If the contract programme (clause 14) showed completion in 18 months and the Contractor actually completed in 18 months, no extension of time claim can be justified.		
Q23 If the Engineer awards an extension of time without costs for a delay attributed to exceptional adverse weather, this prevents the Contractor from claiming an extension of time with recovery of overhead costs.		
Q24 Providing the Engineer never actually instructs the Contractor to accelerate, then no acceleration claim can be justified.		

Q44 What importance do you attach to the initial critical path (if one is shown)?

* great importance
* some importance
* little importance

APPENDIX 6

PUBLICATIONS FROM THE CURRENT RESEARCH

PUBLICATIONS FROM THE CURRENT RESEARCH

Resulting from the work carried out as a part of this thesis, the following papers have already been published:

Scott, S.,(1987), CPM validation of contract claims, proceedings of the International Conference on Modern Techniques in Construction, Singapore, pp 370 - 384.

Scott, S.,(1989), Dealing with concurrent delays, proceedings of the INTERNET International Expert Seminar on the State of the Art in Project Risk Management, Atlanta, pp 111 - 127.

Scott, S.,(1990), Dynamic time-scaled CPM model - a teaching tool, proceedings of the International Conference on Project Management in the Construction Industry, Petaling Jaya, Malaysia, pp 203 - 214.

Scott, S.,(1990), Keeping better site records, International Journal of Project Management, Volume 8, No. 4, pp 243 - 249.

Scott, S.,(1991), Avoiding problems in the teaching of CPM, Civil Engineering Education, Journal of the American Society for Engineering Education, Civil Engineering Division, Volume 13, No. 1, pp 25 - 42.

ADDENDA

ADDENDA

Addendum to Chapter 6,'The ownership of float' (p.6-35)

To be read following,'The issue of float ownership is thus effectively overridden if we accept that networks should be adjusted in this way.'

This view stems from the insights which the adjusted CPM approach to delay claims has brought, but it is perhaps worthwhile examining in a little more detail why this view is held. To the author's knowledge, it has not been said explicitly, but the adjusted CPM approach appears to rely on a particular attitude towards the use of float. When an Employer-responsible delay has consumed float only (as in fig 6.6(a)), this approach will not penalize the Employer while float still exists along that particular path through the network.

The second basic principle which is embodied in this approach is as follows: if an Employer-responsible delay exists on the eventual critical path through the project network, then to identify how long the contractor would have taken to do the work in the absence of this delay, the delay must be removed and the network adjusted accordingly. No interest is then shown in which delays came first: contractor-responsible, delays due to neither party or employer responsible. The network path which dictated final completion time was affected by employer-responsible delays and this is all that need be recognized.

To sum up, the adjusted CPM approach concerns itself principally with the eventual critical path through the project. Where employer-responsible delays have occurred but are not on this path, or a path made critical by adjustment of this path, then these delays will not penalize the employer. However, when an employer-responsible delay does exist on the eventual critical path, its impact on time and cost will be recognized, irrespective of other delays on this same path.

Addendum to Chapter 6,'Checking the contract programme' (p 6-29)

To be read following,'A procedure adopted by some American contractors of including in their programme submittal letter that approval would be assumed unless some response was received within 30 days, seems a reasonable way of overcoming this problem.'

In checking and subsequently approving the contract programme, it should be clear exactly what the engineer is doing. He should not be saying that this is the approved way of carrying out the contract and that only this approved sequence should be used. Matters arising during the contract could easily make the initial programme no longer a valid way of proceeding. Neither should he be accepting responsibility for the contractor's method of working with his approval: the contractor is responsible for ensuring that the most efficient way of carrying out the job is adopted - it is clearly in his interests to do so.

The approval process ought to have quite different functions. It should allow the engineer to assess that the contractor has understood the job fully and has complied with all specified restraints on his method of working. It should also provide the engineer with a copy of the contractor's plan so that he can use it to recognize whether progress is acceptable. For the plan to be useful in this area, it must be as good a representation as possible of the expected progress: the approval process is thus an opportunity for the engineer to influence the plan to ensure that this is achieved.

Because of the possible legal pitfalls which might result from an unrestrained approval of this plan it is common for engineers to approve using carefully selected words. A phrase such as 'no objections will be raised' will often be used in giving this approval. The aim is clearly to comply with the Conditions of Contract while committing the employer to no increased responsibility as a result of the approval.

Addendum to Chapter 6,'Conclusions' (p 6-48)

To be read following,' Having made these statements, it should not be assumed that the author necessarily believes that dispute resolution in the U.S.A. is any more efficient or cost-effective than in the U.K.. These matters have not been addressed.'

Subsequently, a number of other publications covering the U.S. approach to delay claims have been reviewed. Despite this further literature search and analysis, no changes to the current recommendations and conclusions are felt to be necessary. It is accepted that regular agreement of the facts between the contracting parties with respect to progress and delays would always be beneficial, but it is also recognized that such agreement would be difficult to achieve. Even if the contract laid down a condition that the facts must be agreed, it is doubtful whether this would change the different perceptions of the two main parties.

LIST OF REFERENCES

LIST OF REFERENCES

1. Institution of Civil Engineers, (1979), Conditions of Contract 5th edition, The Stanhope Press, London, England.

2. Abrahamson, M.W., (1979), Engineering Law and the I.C.E. Contracts, 4th edition, Applied Science Publishers Ltd., London, England.

3. Wallace, I.N.D., (1978), The I.C.E. Conditions of Contract 5th edition: a commentary, Sweet & Maxwell, London, England.

4. Goodacre, P., (1979), Delays and Disruption in Construction: ascertaining the cost, C.I.O.B., Ascot, England.

5. Worby, G., Tyler, A.H. & Harris, F.C., "Management of Claims", Journal of Building Technology and Management, July/August 1985, pp 23-25.

6. Hughes, G.A., (1983), Building and Civil Engineering Claims in Perspective, 2nd edition, Longman, London, England.

7. Joint Contracts Tribunal, (1980), Standard Form of Building Contract, RIBA Publications Ltd., London, England.

8. Powell-Smith, V. & Stephenson, D., (1989), Civil Engineering Claims, BSP Professional Books, London, England.

9. Audas, M., (1989), Extensions of Time, 2nd edition, C.I.O.B., Ascot, England.

10. Trickey, G., (1983), The Presentation and Settlement of Contractor's Claims, Spon, London, England.

11. Marks, R.J., Marks, R.J.E., Grant, A.A. & Helson, (1978), P.W., Aspects of Civil Engineering Contract Procedure, 2nd edition, Pergammon International Library, England.

12. Arditi, D., (1973), PhD thesis on: An investigation into the behavioural and technical factors affecting success in the use of network analysis in the construction industry of Great Britain, Loughborough University.

13. Hale, L.K., (1968), discussion of a paper by Wade, D.H. entitled 'Critical path analysis and the civil engineering industry', proceedings of the Journal of the I.C.E., vol 40, pp 403 - 416.

14. Wade, D.H., (1968), Critical path analysis and the civil engineering industry, proceedings of the Journal of the I.C.E., vol 39, pp 289 - 303.

15. Forinton, M., (1972), Civil Engineering Contracts and Claims, C. Knight & Co., London, England.

16. Woodward, J.F., (1976), Analysis of reasons for failure to adopt networks in project management, proceedings of the Fifth INTERNET Conference, Birmingham, England, pp 161 - 170.

17. Hancock, P.H.D., (1968), discussion of a paper by Wade, D.H. entitled Critical path analysis and the civil engineering industry, proceedings of the Journal of the I.C.E., vol 40, pp 403 - 416.

18. White, A., (1985), The critical path method and construction contracts: a polemic, Journal of Construction Management and Economics, volume 3, no. 1, pp 15 - 24.

19. Fondahl, J.W., (1975), Some problem areas in current network planning practices and related comments on legal applications, Technical Report No. 193, The Construction Institute, Stanford University, USA.

20. Morris, D., (1982), Modelling project milestones: dependent activities, Journal of the Construction Division, American Society of Civil Engineers, vol. 108, no. CO2, pp 247 - 259.

21. Eshete, S. and Langford, D., (1987), Planning techniques for construction projects, Journal of Building Technology and Management, February/March 1987, pp 30 - 31.

22. Walton, H., (1968), Optimum level of detail, from Critical path analysis in practice edited by G. Thornley, Tavistock publications, London, England, pp 31 - 33.

23. Tavistock Institute, (1966), Interdependence and uncertainty, Tavistock publications, London, England.

24. Major, W.T. and Ranson, A., (1980), Building and engineering claims, Oyez publishing, London, England.

25. Wickwire, J.M. and Smith, R.F., (1974), The use of critical path method techniques in contract claims, Public Contract Law Journal (USA), vol. 7, no. 1, pp 1 - 45, USA.

26. Clark, J.B., (1979), Claims and the project schedule, from the Course Manual of 'Construction Scheduling and Proof of Claims', Federal Publications inc., USA.

27. Rubin, R.A., Guy S.D., Maevis A.C. and Fairweather V., Construction claims, analysis, presentation, defense, Van Nostrand Reinhold, London, England.

28. Sweet, J., (1985), Legal aspects of architecture engineering and the construction process, 3rd edition, West Publishing Co., New York, USA.

29. Hohns, H.M., (1979), Preventing and solving construction contract disputes, Van Nostrand Reinhold, London, England.

30. Currie, O.A., (1979), The expert/consultant and witness, from the Course Manual of 'Construction Scheduling and Proof of Claims', Federal Publications inc., USA.

31. Mitchell, R.S. and Fitzgerald, R.M., (1979), Performance problems and remedies, from the Course Manual of 'Construction Scheduling and Proof of Claims', Federal Publications inc., USA.

32. Schor, L., (1979), Scheduling clauses and regulations, from the Course Manual of 'Construction Scheduling and Proof of Claims', Federal Publications inc., USA.

33. Driscoll, T.J., (1979), Choosing and using scheduling techniques, from the Course Manual of 'Construction Scheduling and Proof of Claims', Federal Publications inc., USA.

34. Antill, J.M. and Woodhead, R.W., (1982), Critical path methods in construction practice, 3rd edition, Wiley, New York, USA.

35. Jaafari, A., (1984), Criticism of CPM for project planning analysis, Journal of Construction Engineering and Management, American Society of Civil Engineers, vol. 110, no. 2, pp 222 - 233.

36. Antill, J.M., (1968), The use of network analysis for the evaluation of work changes and delays to construction projects, thesis submitted for the degree of Master of Engineering, Department of Civil Engineering, New South Wales.

37. Galloway, P. and Nielsen K., (1981), Schedule control for PCM projects, Journal of the Construction Division, American Society of Civil Engineers, vol. 107, no. CO2, pp 323 - 335.

38. Kraiem, Z.M.and Diekmann, J.E., (1987), Concurrent delays in construction projects, Journal of Construction Engineering and Management, American Society of Civil Engineers, vol. 113, no. 4, pp 591 - 602.

39. Oppenheim, A.N., (1972), Questionnaire design and attitude measurement, Heinemann, London, England.

40. Gardner, G., (1976), Social Surveys for Social Planners, Open University Press, Milton Keynes, England.

41. Douglas, J.D., (1985), Creative interviewing, Sage Library of Social Research, Sage publications, Beverly Hills, U.S.A..

42. New Civil Engineer, Consultants File 1988, Thomas Telford Ltd., London, England.

43. New Civil Engineer, Contractors File 1988, Thomas Telford Ltd., London, England.

44. Department of Transport, (1989). Notes for guidance on the Specification for Highway Works, Part 1, HMSO, London, England.

45. Institution of Civil Engineers, (1991), Conditions of Contract 6th edition, Thomas Telford Ltd., London, England.

46. Institution of Civil Engineers, (1991), The New Engineering Contract, Thomas Telford, London, England.

47. Fine, B., (1974), Tendering strategy, Journal of Building, 25th October 1974, pp 115 - 121.

48. Lawler, E.E. & Rhode, J.G., (1976), Information and control in organisations, Goodyear publishing co., California, USA.

49. Bentley, T.J., (1976), Information, communication and the paperwork explosion, McGraw Hill, London, England.

50. South Yorkshire County Council, (1984), Procedure for contract supervisory staff, internal document.

51. Pilcher, R., (1976), Principles of Construction Management, 2nd edition, McGraw Hill, London, England.

52. Nahapiet, J. and Nahapiet, H., (1985), The management of construction projects, Chartered Institute of Building, London, England.

53. Melin, J.W. and Whiteaker, B., (1981), Fencing a bar chart, Journal of the Construction Division, American Society of Civil Engineers, vol. 107, no. CO3, pp 497 - 507.

54. Lee, D.M., (1982), discussion of a paper by Melin and Whiteaker entitled 'Fencing a bar chart', Journal of Construction Engineering and Management, American Society of Civil Engineers, vol. 108, pp 357 - 359.