25 Years of Managing Construction Risk in ASIA
1988 - 2013

# Time Management

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The Global Leader in Managing Construction Risk

# Table of Contents




Vice President & Managing Director
Hill International Inc

## Understanding and Managing Time

'Without effective time management there can be no effective resource management, cost management, nor allocation of liability for slippage, its recovery, or accountability'.

So says the CIOB 'Guide to Good Practice in the Management of Time in Complex Projects' (published by Wiley Blackwell 2011 Edition). But why is time so important to those of us who make our living in construction?

All construction contracts have start and end dates, usually in the form of a Date of Commencement and a Date (or dates, if more than one section) for Completion. That is because a degree of certainty is required by both parties. For the purchaser - if the project is a hotel, office or residential development – when can it open, and when can advance publicity begin? If it is a road or rail project – when can the owner/operator expect to begin earning revenue? When will a ship be ready for its first charter or an oil refinery for its first product export? For the Contractor – how quickly can he begin submitting applications for payment? How much will his labour, plant, overheads and prelims cost be? You can see where this is leading – time is always money, and money is why we are all in business!

It is an unfortunate consequence of this that construction disputes, albeit nominally about money, invariably involve issues to do with time. Extension of time claims self-evidently involve time, as do claims for liquidated damages. Similarly, prolongation costs claims, Loss and Expense claims and disruption claims are all fundamentally about time. Even claims seemingly unconnected with time, such as professional negligence or certain types of insurance claim have a time element. The effective management of time is therefore a part of everything we do in construction and it is at the heart of most construction contracts.

## Preparing and Understanding Contract Programmes

When we talk about Contract Programmes it is safe to say that we don't really mean it! Under most of the standard forms of contract the programme itself is not a contract document, although its incorporation is an option under some of the UK forms (for example GC/Works, ECC or NEC3). However, most of those same standard forms call for a programme in some shape or form. We'll come back to that point, but why is it not a good idea to make the programme a Contract Document?

My colleague Keith Pickavance[1] says '*…any attempt to render the content of a schedule [programme] contractually binding, at any stage, is likely to prove to be at best meaningless and, at worst, a serious inhibition to effective time management*'.

Keith says that the programme should not be a 'one-step' preparation at every part of which the Contractor is to aim, and against which the failure to hit every part of it can be measured (and penalties applied!). In fact, the programme should be dynamic for the purposes of managing time. When in the future and in what sequence the planned work is to be performed, so that the intended work and the consequences of any changes can be predicted and managed. The programme should be allowed to evolve as knowledge grows and as the detail of the project evolves.

[1] Keith Pickavance, 'Delay and Disruption in Construction Contracts', London, Sweet & Maxwell, 4th Edition, 2010


Vice President & Managing Director
Hill International Inc

As to the form and content of the programme almost every standard form of contract is silent on the subject. This is largely because there are as many different approaches to programming as there are to wallpaper design, not to mention the plethora of software packages around, and employers see the programme as something that the contractor should produce. The parties are therefore reluctant to commit to specifics about the programme. However, there is no good reason why a contract should not stipulate:

- The type of programme – should it be a full critical path network with resources or just a simple bar chart?
- Who should prepare it – is it to be the employer, the contractor or both?
- Its purpose – is it just an indication of when the job might be finished or is it a detailed method statement showing when things are to be procured, drawings are to be produced, approved and issued, and work carried out?
- What else does it relate to (e.g. other schedules, IRS etc.) – is there an Information Required Schedule, is there an overarching Master Schedule, are there other contractors' schedules to consider?
- Manner and timing of preparation – how is it to be presented (in hard or softcopy, or both, and in how much detail) and when, in the context of the contract timescale?
- How it should be revised and updated – by what mechanism should the programme be revised (see for example the NEC3 procedure) and how should progress be both measured and recorded?
- How it should be used in relation to EOT and Costs issues?

These are just some of the factors that could be readily spelled out in a contract without tying either party to any particular programming method or software package. It is not unknown however (and in fact in the petrochemical industry it is common practice) for the contract to stipulate the software to be used, the type of programme and even the minimum level of detail (number of activities, maximum activity duration etc.).

When it comes to what the contracts say about the programme the shocking truth is – not very much! The JCT forms (1980, 1998 and 2005) say next to nothing and only call for 'a programme' to be submitted. Nothing is stipulated about the form, content or purpose of the programme. The FIDIC 1999 (red book) is a little more helpful in that it says[2] that:

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

a) *the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design (if any), Contractor's Documents, procurement, manufacture of Plant, delivery to Site, construction, erection and testing,*
b) *each of these stages for work by each nominated Subcontractor (as defined in Clause 5 [Nominated Subcontractors]),*
c) *the sequence and timing of inspections and tests specified in the Contract, and*
d) *a supporting report which includes:*
    i. *a general description of the methods which the Contractor intends to adopt, and of the major stages, in the execution of the Works, and*

[2] FIDIC Conditions of Contract for Construction, First Edition 1999 at Clause 8.3



Vice President & Managing Director
Hill International Inc

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

That is helpful to a point, but as I have already stated, the standard forms are pretty much universally silent on the specification for the programme. So where to look?

The Society of Construction Law's '*Delay and Disruption Protocol*', published in October 2002 (but not updated since!) has the stated aims of providing guidance to all parties to the construction process when dealing with time/delay matters and providing the material necessary for the parties to avoid unnecessary disputes. All very noble, and it contains, at Appendix B, a model programme specification clause dealing with such issues as the submission of the programme, the preparation of the different evolutions of the programme, methods of construction, cash flow and revising and updating the programme while Appendix C contains a model records clause suggesting what records should be kept and in what detail. However, in my view, the Protocol does not go far enough. It doesn't address the detail of the programme or the mechanics of its use. As Keith Pickavance observes, whilst the CIOB Guide is not a contract document it gives detailed advice in relation to subjects such as:

- Programme types
- Scheduling techniques
- Resource planning and scheduling
- Software considerations
- Programme design
- Programme preparation
- Work Breakdown Structure
- Activity identification
- Activity descriptions
- Activity durations
- Ascertaining activity durations
- Calendars
- Activity content codes
- Cost codes
- Logic
- Constraints
- Float
- Risk and contingencies
- Critical path
- Planning method statement
- Quality assurance

And he points out that although an approach using the detail of the Guide might be criticised as 'overly prescriptive', this is the minimum information necessary for a competent programme specification to be used for the purposes of managing time. Without such a detailed specification of what the Contractor is to provide it is not possible to determine (objectively) whether what is actually provided complies with the Contract.

Let's assume that we are preparing a programme for a large-scale, long duration construction project. The Contract is silent on the form of the programme and simply calls for it to be submitted at some point after the effective date of the contract. In preparing a Programme for such a contract it is important to follow a strategy. Start your planning with the Design Stage and begin by drafting a method statement. This should clearly identify any constraints or potential barriers, and what assumptions have



Vice President & Managing Director
Hill International Inc

been made. It is important to sort out what records are to be kept and who is to keep them. This will be fundamental to updating and reviewing the programme in the event of change. Establish the communication process for the project such that all interested parties have timely possession of the project scope and objectives, the planning method statement, the programme itself, periodic progress records and updates and a register of the risks that might affect the project.

The next stage in the process is the development of the programme itself. Never lose sight of the fact that the purpose of the programme is: '*…to indicate when in the future and in what sequence the planned work is to be performed, so that the intended work and the consequences of any changes, or departures from that intention can be predicted, communicated and managed efficiently*.' (CIOB Guide, Section 3 at 3.1.2). Then there are the considerations that need to be taken into account:

- Time for completion
- Sectional and key completion dates
- Unspecified milestones
- Access, egress and possessions
- Information-release dates
- Submittals and approvals
- Procurement strategy
- Procurement schedule
- Materials' delivery and storage
- Temporary works
- Temporary traffic arrangements
- Working hours and holidays
- Design responsibility
- Complexity of design
- Adjoining owners
- Risk allocation
- Subcontractors and suppliers
- Separate Contractors
- Employer's Contractors
- Employer's goods and materials
- Nominated subcontractors
- Utilities and statutory undertakings
- Third-party issues
- Licences and permissions
- Provisional and prime cost sums
- Specifications
- Bills of quantities
- Local regulations
- Environmental conditions
- Health and safety
- Noise restrictions
- Labour and plant resources
- Logistics
- Construction philosophy
- Method of construction
- Sequence of construction
- Schedule requirements
- Updating requirements
- Notice requirements
- Reporting requirements
- End-user requirements
- Testing and commissioning
- Furniture and fittings
- Phased occupation
- Occupation and handover
- Partial possessions

There are many factors listed here and although it might appear a bit daunting they are all things that should be considered when developing a programme for a complex construction project.

Once all the relevant factors have been considered and the necessary information gathered it is appropriate to consider the programme technique to be used. There are many different approaches but they can be grouped under these five basic heads:

- Bar Chart
  - The bar chart was first used in the 1930s by an American engineer named Henry L Gantt (which is why it sometimes called a Gantt chart) and it serves as a static illustration of intent. It does not allow the effect of change to be easily measured and does not allow the implications of necessary links between activities to be determined.

- Line of Balance
  - The Line of Balance diagram is commonly used to indicate the progression of resources through a multiplicity of areas, and is a useful technique for coming to grips with the



Vice President & Managing Director
Hill International Inc

underlying philosophy of resource logic. It lends itself to the management of linear projects such as railways, roads and pipelines.

- Time/Chainage
  - Time/chainage charts are also used in work that is linear in nature and provide a graphical indication of both the time required and location for each work-front. Widely used in civil engineering works it is of limited use in complex building projects.

- Arrow/Precedence network
  - These two methods are the original critical path network techniques. The arrow method has its roots in a number of parallel developments. In 1955 the CEGB Operational Research Section developed a basic method for planning work to power-plant shutdown. In 1957 it was described as defining the 'longest irreducible sequence of events' and by 1960 that had become the 'major sequence' and the Keadby power station shutdown time had been reduced to 32% of previous average time. At the same time in 1958 (February) the US Navy Special Projects Office began a programme called PERT, which was an acronym for 'Programme Evaluation Research Task'. By July of the same year the name had changed to 'Programme Evaluation Review Technique' and in October it was applied to the Fleet Ballistic Missile programme. It was credited with saving 2 years in the development of the Polaris missile. Following the advent of affordable computing the method was changed to become more computer-friendly and became known as the precedence method, which is still in use today behind some of the industry standard packages such as Primavera. Both are methods for determining by calculation the critical path (or paths) through a sequence of logic.

- Linked Bar chart
  - This method will be familiar because it is that which is offered by most of the modern scheduling software packages. It is also the network-illustration method of choice for project reporting but does have a shortcoming in that the way in which the programme is developed encourages the use to 'paint a picture' rather than think in terms of logic and sequence and then allow the software to calculate the schedule.

Having decided on the appropriate technique it is then necessary to consider the points of detail that go in to making up the programme. On the assumption that we are preparing a linked bar chart using a proprietary software package (e.g. Primavera) we need to consider things like the appropriate time units. The time units are used to express the duration of each activity and thought should be given to what is manageable. It would be pointless expressing durations in hours if the project is large and has a long-duration. In that case, days would be appropriate. On the other hand, if your project is the replacement of a gearbox on a Formula 1 racing car then you need to think in terms of minutes! Non-working periods such as weekends and holidays should be identified so that work is not programmed to occur when there is no chance of it being carried out.

The Work Breakdown Structure, which is the means by which the full project scope is set out in manageable component parts, also needs to be considered. It needs to take the form of a structured hierarchy with, at its highest level, the project as a whole, and at its lowest level identifying each task or group of tasks to be accomplished. It is a complex subject and is covered in detail at Section 3.8 of the CIOB Guide.

The numbers or codes used to uniquely identify individual activities need to be defined. These can also be used to identify project zones, building levels, nature of activities etc.



Vice President & Managing Director
Hill International Inc

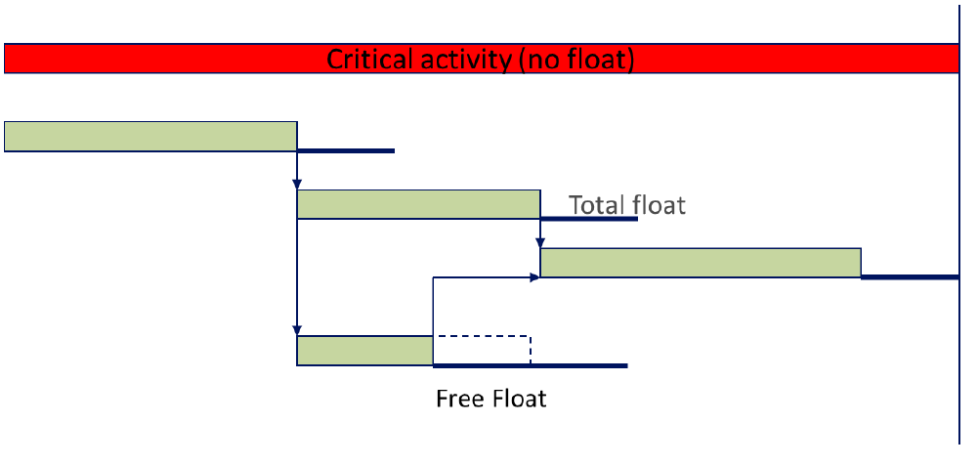
It is also sensible to consider whether the activities in the programme should carry resource allocations. Most software packages have the capability to allow multiple resources to be allocated to each activity and the resources are not limited to labour. The allocations can be plant, materials – even money!

Fundamentally, the programme consists of activities (i.e. the tasks to be carried out) and logic (the relationships between those activities). Only after sorting out the levels of detail, WBS, Codes and resource types and determining the duration of each task can we then begin to develop the programme itself and the most time-consuming part is then determining the logic. The most commonly used logic relationships are Finish-to-start, used to make the start of the succeeding activity dependent upon the finish of the preceding activity, Start-to-start, used to make the start of the succeeding activity dependent upon the start of the preceding activity and Finish-to-finish, used to make the finish of the succeeding activity dependent upon the finish of the preceding activity. There is a fourth relationship type (Start-to-finish) but it is not widely used.

## Analysing and Updating Programmes

One of the benefits of modern software packages is the comparative ease with which the programme can now be developed. In simple steps, logic links can be added with a few clicks of the mouse and the programme can be scheduled, or 'time analysed' with a few more. It is at this stage that the critical path (or paths) can be determined and float can be identified.

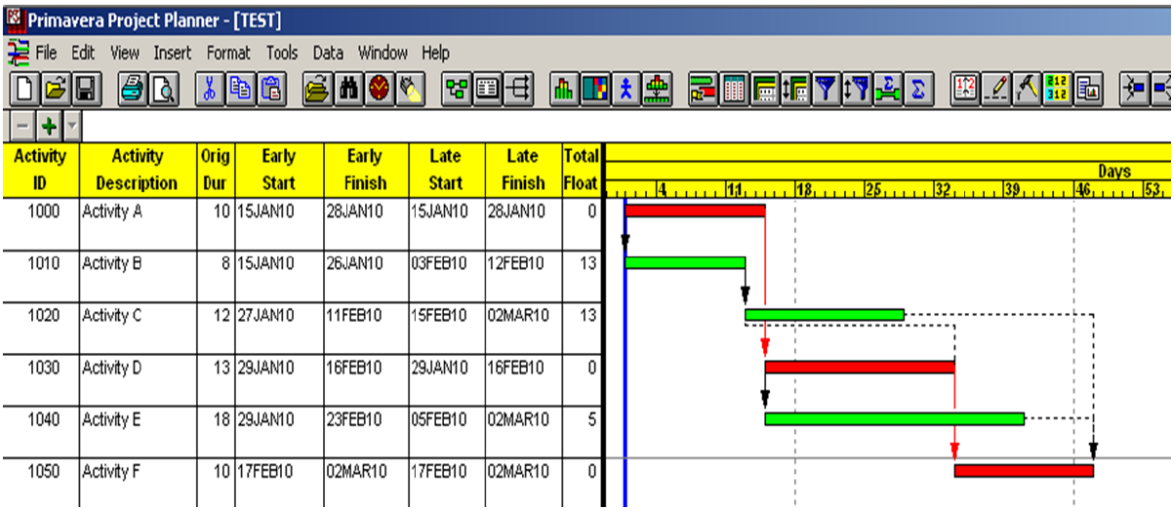
The concept of float is one that is often misunderstood. In simple terms, float is the time available to an activity in addition to its duration, but what should be remembered is that there is a distinction between Total Float and Free Float. The difference is that TF is the time by which an activity can be delayed without affecting Project Completion (but with an inevitable effect on succeeding activities) whereas FF is the time by which an activity can be delayed without affecting other activities. The distinction can be illustrated like this.




The red bar at the top is critical because it fills the time available for it. It has no float. The second sequence of activities all have a small amount of TF which, if eroded by delay or prolongation to the first activity, would erode by the same amount and the activities would all be delayed. The fifth activity however, has an amount of FF which would allow it to be delayed or prolonged by a certain period without affecting the succeeding activity. The benefit of using software packages is that all of this is accurately calculated in milliseconds provided of course that the logic is correct in the first place. It is

possible to calculate criticality and float manually and I could show you how to do it but it would take more time than we have available.

Once the programme has been time-analysed the critical path can easily be identified. It is the path with least float and in this case it is the path with no float indicated by the red bars and red logic links.




| Activity ID | Activity Description | Orig Dur | Early Start | Early Finish | Late Start | Late Finish | Total Float |
|---|---|---|---|---|---|---|---|
| 1000 | Activity A | 10 | 15JAN10 | 28JAN10 | 15JAN10 | 28JAN10 | 0 |
| 1010 | Activity B | 8 | 15JAN10 | 26JAN10 | 03FEB10 | 12FEB10 | 13 |
| 1020 | Activity C | 12 | 27JAN10 | 11FEB10 | 15FEB10 | 02MAR10 | 13 |
| 1030 | Activity D | 13 | 29JAN10 | 16FEB10 | 29JAN10 | 16FEB10 | 0 |
| 1040 | Activity E | 18 | 29JAN10 | 23FEB10 | 05FEB10 | 02MAR10 | 5 |
| 1050 | Activity F | 10 | 17FEB10 | 02MAR10 | 17FEB10 | 02MAR10 | 0 |

Identifying the critical path is an important part of managing the programme because it is generally only critical delay, or delay to activities on the critical path that will give entitlement to extensions of time.

The next most important stage in managing time is in updating the programme. It is essential to the management of time because without it the programme is merely a target against which historical failure is plotter. By updating with progress the programme becomes a dynamic model against which predictions can be made, problems can be identified and remedies tested and implemented.

Note that it is not progress monitoring, nor is it revising or changing the programme; it is merely the addition of as-built data in the form of actual starts, remaining durations and actual finishes to the programme and the subsequent re-calculation of the critical path.

Progress can be recorded using Actual Start and Actual Finish dates, recording the Remaining Duration and Percent Complete.

Most software packages link the remaining duration and percent complete (e.g. if the original duration = 50 days and remaining duration is entered as 25 days the software will calculate progress at 50%. Similarly, if OD = 50 days and 50% progress is entered the software will calculate RD at 25 days.) Those links can be broken but the schedule is always re-calculated using the remaining duration.

Entering Actual Start does not normally cause either remaining duration or percent complete to be calculated and entering Actual Finish causes remaining duration to be zeroed and percent complete to be changed to 100%.

The first action in the update process is to enter the date to which the programme is being updated (i.e. the date on which the progress was recorded). The actual start date of activities that are in progress is recorded together with the estimated remaining duration. Any activities that have been completed since the last update would also have their actual finish date entered. The software automatically


Vice President & Managing Director
Hill International Inc

calculates the percent complete and, on instruction from the user, the balance of the programme (i.e. the un-started and incomplete part) is re-calculated.

The advantages of updating the programme should be pretty obvious. They include the fact that the impact of change can be accurately predicted (irrespective of whether the change is in logic, resource availability or activity detail), labour resource planning is made more accurate and reliable because achieved rates of productivity can be calculated and used to adjust future requirements. The programme can also be used to model 'what if' scenarios e.g. what happens if we change the sequence because a piece of plant looks like it might be late, or what would be the impact of instructing a change to the design? The progress update also allows the early identification of problems thereby allowing the maximum opportunity to use the programme to find solutions (perhaps in the form of acceleration or other mitigatory measures. Finally, the use of progress updates allows the ready identification of the causes and effects of disruption, which means that its consequences can be more cost-effectively managed.

Fundamentally, the use of accurate and regular progress updates means that regular and high quality management information can be derived and the experience is that this can only encourage the project team to use it. The benefits of that should be obvious.

It is to be hoped that this presentation has given an overview of the importance of good Time Management and of the importance to that of the programme and progress updates. I have drawn heavily on the CIOB '*Guide to Good Practice in the Management of Time in Complex Projects*' and it should be noted that, in addition to the topics covered by this presentation the Guide also gives guidance on subjects such as Progress Monitoring, the use of Target Programmes, Resource Monitoring, Cash flow reporting and forecasting, and the use of programmes in acceleration and other recovery measures. It should not be forgotten though that of fundamental importance to successful Time Management is the process of communication and reporting, and these are also covered by the Guide.

## About the Writer

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Steve has more than 30 years of consulting experience including construction, process engineering, shipbuilding, ship conversion, petrochemical and strategic planning of infrastructure and facilities projects. He has had over 200 appointments as expert witness on delay-related issues in both arbitration and litigation. He has given both written and oral evidence on a number of occasions.

In 2008 Steve gained accredited mediator status with the Institute of Arbitrators. Steve has written and presented a number of articles on programming matters such as the ownership of float, the preparation of standard methods of programming, and the use of ICT in the preparation of claims. Steve was also one of the protagonists in the 'Great Delay Analysis Debate' held at King's College in London under the auspices of the Society of Construction Law.