

Chapter 1

An Introduction to Planning and Scheduling

A brief history of planning and scheduling

Frederick Winslow Taylor was the founder of modern scientific management. His studies in the latter part of the 19th century formed the basis for management thinking in the 20th century and continue through to the present. Currie (1977) states that Taylor's work and philosophy may be seen in three major phases. First, he made improvements in the management of production. These sprang from his application of scientific methods. Second, he introduced systems of pay designed to produce 'a fair day's work for a fair day's pay'. Then, moving from the individual scale to the overall scale, he produced his 'grand design' for an industrial society. He hoped that this 'grand design' would lead to improved standards of living. His detailed, careful analysis of production tasks and functions led to new machines and tools, new methods of production control and stock control and new office procedures. Taylor's contribution to manufacturing production scheduling was establishing the planning office in a separate location away from the production area and the recognition that planning was a decision making process that required sharing of information. This and his other works attracted the attention of many other industrialists and professionals.

Henry L. Gantt (1861–1919) was a teacher, draughtsman, engineer and management consultant. He was contemporary and protégé of Taylor, and between 1887 and 1893 he worked with him in his experiments at the Midvale Steel Works (Currie, 1977). His contribution to manufacturing production management includes the application of scientific analysis to all aspects of production, the introduction of tasks and bonus systems where the bonus was linked to how well managers taught employees to improve performance and the social responsibility of business. Gantt focused on the motivation of workers and the application of knowledge to the advantage of all concerned with a

business. He believed that business organisations had an obligation to the welfare of the society in which they operate and this directed much of his thinking. He developed the Gantt chart, a chart that allowed supervisors to identify and schedule the work of each worker and then review and assess the actual production. Gantt did *not* invent the bar chart, the concept of bar charts pre-date Gantt's work by at least a century. Gantt took existing methods of visually displaying work tasks and developed them to produce a new chart to form a visual statement of productivity. He also recognised the advantages of reducing inventory and clean, well laid out workspace and developed other management techniques (Weaver, 2012).

Critical path methods

For the first half of the twentieth century the bar chart was the dominant technique for planning and scheduling on projects of all sizes. This changed in the 1950s. A bar chart is excellent at showing *when* activities are scheduled to take place. However, it fails to show the *inter-relationships* between activities and the effect of delay in individual activities on the overall project. The decade of the 1950s included many major military, industrial and infrastructure projects both in the United Kingdom and the United States, and new systems were sought to manage these complex projects. Within the operational research community there was widespread interest in solving the problem of modelling the inter-relationship between the activities within a project.

By 1957 the Central Electricity Generating Board (CEGB) in the United Kingdom had developed a technique for 'identifying the longest irreducible sequence of events'. At the same time work in the United States, the U.S. Navy Special Projects Office was devising a means of planning and controlling complex projects. July 1958 saw the publication of a report entitled PERT, Summary Report, Phase 1 in which the technique entitled the 'Programme Evaluation Review Technique' (PERT) was proposed. In October 1958 it was decided to apply PERT to the Fleet Ballistic Missiles Programme. Meanwhile at the U.S. company E.I. du Pont de Nemours a technique called the Critical Path Method was under development. (For more details see Lockyer, 1974.)

Early successes of these techniques led to their widespread adoption by project managers, and the next decade saw the development of the techniques by researchers in academia and industry and their use across a range of projects. Originally the calculations were undertaken manually, then using computer programs operating on large mainframe computers. The generic term 'Critical Path Analysis' (CPA) arose emphasising the ability of the technique to identify the key activities that form the shortest duration for the project.

Two forms of the technique emerged: activity-on-arrow and the precedence method. By the early 1970s CPA was the *de facto* standard for planning and scheduling major projects and was adopted by both clients and contractors for project planning, monitoring and control. However, project managers soon discovered that adopting the technique did not guarantee the success of the project. For some projects the technique simply highlighted the problems. On others the technique (or rather its use) became the problem.

A report by NEDO compared construction performance on major engineering projects in the United Kingdom, Europe and the United States. It found ‘That there was no correlation across the case studies between the sophistication with which programming was done and the end result in terms of successful completion on time’.

It became clear that CPA-based planning and scheduling systems were only an aid, albeit an important one, to the project manager and not a panacea for poor management. ‘There was a general feeling that project planning was generally unsuccessful, that project planning using network planning was even more unsuccessful and that network planning using computers was the least successful of [all] techniques’ (NEDO Report, 1983). Enthusiasm for the technique waned. Many project managers who were required contractually or by their organisations to use the technique paid only lip service to it.

Its use was resurrected by the introduction of the micro-computer, now generally known as the PC.

The impact of the PC

The introduction of the personal computer/micro computer provided cheap ‘local’ computing power for every office and every construction site. This meant that the time required for the preparation of plans and the production of bar chart schedules could be significantly reduced and they could become readily available to the construction team. ‘The bar chart was no longer out of date before you pinned it to the wall’ (Reiss, 1995).

The success of the IBM PC (introduced in 1981), its subsequent models and alternative computer products resulted in the production of many new software applications including new software for CPA. Soon, CPA software was re-packaged and marketed to all industries as a ‘Project Management System’. New features were added. Some of these products adopted a new approach to inputting and displaying project data that was based on a bar chart format. This combined with improved facilities for producing and printing the output of schedules led to the ‘linked bar chart’ software product. This linked bar chart format became the preferred form of planning and scheduling for many planning engineers and led to a resurgence in the use of project management software.

With the opportunities of new computer systems came an awareness that the successful adoption of computer systems requires more than just hardware and software but consideration of data, procedures and people. There came a wider appreciation of the need to plan the implementation of systems around the users, not the computer hardware and related equipment. Moreover, there was a clear need to develop and work with collaborative systems whereby all parties involved in the project may contribute to the project planning scheduling and monitoring process. The boundaries between the technical innovations of information and communication technologies and the human aspects of systems adoption and performance became less distinctive. However, the success of project management systems in the overall management of construction projects remained inconsistent. This led to new systems and new thinking.

New systems and new thinking

The decade commencing 1990 saw the development of two important developments in planning and scheduling: Critical Chain Project Management (CCPM) and Last Planner. Both were the result of the realisation that, even with the cheap computing power and many additional features, the adoption of existing project management systems could not ensure project success.

CCPM focuses on the uncertainty in schedule activities and identifies the key activities that, based on time and resource constraints, form the ‘critical chain’ for the construction work. Rather than adopt traditional critical path methods that allow individual managers to create and use up buffer time relating to ‘their’ activities, CCPM creates a ‘project buffer’ and argues that production should monitor this buffer time on an on-going basis, always allocating resources to critical chain tasks. CCPM stresses the importance of focusing on the critical activities and the resources required to complete these activities. It argues that by monitoring the project buffer time you will ensure successful project completion. Advocates of CCPM claim that the introduction of the CCPM methodology ensures project success, reduces project durations, enables increased project throughput with no resource increases, and reduces manager and worker stress, all with minimal investment.

Last Planner was developed from research that concluded that even with the strict adoption of critical path planning techniques only 50% of the activities on a typical construction project were completed to schedule. One major shortcoming of CPM is that it is ill suited to direct production on site. Ballard and Howell (1992) argued that the CPM approach as a basis for production planning was fundamentally flawed and that production should only commence if all the resources required for the completion of an activity are available, that is, you should consider not only what *should* be done but what *can* be done. Introduced in 1992 the Last Planner System has become the platform for Lean Construction and is now fully recognised as a proven approach to production-based construction management.

New information and communication technologies

The last decade has seen the emergence and acceptance of Building Information Modelling (BIM) and Virtual Prototyping as the basis for the design, production and maintenance of many new buildings. These technologies together with a focus on sustainable building developments and new procurement requirements are influencing the thinking of both public and private clients who are demanding new standards and new ways of working.

The ability to model the building product and link the contents of the building model to other systems was first developed in the 1980s. With respect to construction planning this became known as 4D Planning and typically comprised the ability to link the elements and quantities from the computer model to project management software to introduce the dimension of time and generate simulations showing how the construction would proceed throughout the duration of the project. (Similarly, using product model data to analyse cost has become known as 5D planning.)

The use of digital product models for all aspects of building design and management is now known as building information modelling or BIM. The development

of realistic graphical simulations for planning the broader aspects of physical and operational aspects of the building or facility is known as virtual prototyping or virtual construction. The benefits of these tools and techniques are already proven on large commercial buildings and infrastructure works, and they are increasingly being adopted on medium and smaller projects. In some countries they are a recognised part of the government procurement process. In 2011 the British Government announced their intention that, by 2016, all public sector contracts would be procured using BIM.

It is within this context of planning and scheduling in the twenty-first century that we need to consider fundamentals of planning and scheduling.

Planning

A plan is ‘a formulated and especially detailed method by which a thing is to be done’ (Oxford, 2002). This definition indicates the importance of working towards an objective and identifying how that objective will be achieved. Within a construction context the objective may be simply stated as the successful completion of the design and construction of the building or infrastructure. The ‘plan’ for the completion of any building, let alone a large commercial building or complex infrastructure works, will comprise a number of linked plans.

It is easy to think of planning as the production of a time schedule but this is only one aspect of successful project planning. There is always a need to consider planning in a wider context. Planning for a project must include not only consideration of time but also consideration of cost, quality, health and safety and other aspects such as design and production. Many construction writers and construction researchers have considered what constitutes planning from this broader perspective context and provided appropriate definitions. Here are some:

Planning is ‘the determination and communication of an intended course of action incorporating detailed methods showing time, place and the resources required’ (CIOB, 2011).

Planning is ‘the creative and demanding mental activity of working out what has to be done, how, and when, by whom, and with what, i.e. doing the job in the mind’ (Neale and Neale, 1989).

Planning is ‘a decision making process performed in advance of action which endeavours to design a desired future and effective ways of bringing it about’ (Ackoff, 1970).

Planning is ‘the production of budgets, schedules, and other detailed specifications of the steps to be followed and the constraints to be obeyed in project execution’ (Ballard and Howell, 1998b; Ballard, 2000).

There are many more. Whatever definition is chosen it is clear that a number of factors emerge:

- Planning precedes execution. (You plan before you commence work.)
- Planning is a process and it is important to complete all the stages in the process.

- Planning is more than an aid to the successful completion of the project; it is an essential part of the project.
- Planning is a creative and demanding mental activity.
- To plan you need to make decisions.
- The objective of planning is to ensure that things happen successfully.
- The output of planning comprises schedules and budgets and information for others to use.
- The results of planning have to be communicated to others.
- Having set in place plans it is necessary to monitor progress and, in the event of the unexpected or failing to achieve expected performance, re-plan.

Who plans?

Everyone should plan the work for which they are responsible. All those responsible for the management of construction work, client, designer, contractor and subcontractors, need to plan. Each party within a project will be working to a different schedule that reflects their own requirements. Planning takes place within different parts of the organisation and at all levels within the organisation. Within the client, designer or contractor's organisation there is the likelihood that different programmes for the same project will exist. Within the contractor's organisation the estimator, project manager, site agent, site engineer and subcontractor/gang leader will have different plans. What is important is that all parties and all within the organisation are working to integrated plans that contribute to the overall objectives of the project master plan.

Planning, programming and scheduling

The term programming is based on the traditional production of graphical, paper-based schedules. The production of such schedules requires the planner to identify and state the activities involved, the timing of activities and their durations. From this information a chart showing the activities involved in the project, key dates, material and equipment delivery dates, manpower requirements and when subcontractors would be involved in the site production, would be produced.

The term scheduling has now largely replaced programming. Scheduling has been defined as the process of 'quantifying the programme' and 'the production of computerised calculated dates and logic' (see Uher and Zantis, 2011; CIOB, 2011). Within this text we shall use the term scheduling to cover all aspects of the production of bar charts, networks, method statements and other material relating to the project.

Although the terms planning and scheduling are often used synonymously they are separate activities. Here the Chartered Institute of Building (CIOB), definition is useful: 'Project planning is an experienced-based art, a group process requiring contribution from all affected parties for its success. Scheduling is the science of using mathematical calculations and logic to predict when and where work is to be carried out in an efficient and time-effective sequence' (CIOB, 2011).

Planning requires decisions concerning:

- The overall strategy of how the work process is to be broken down for control
- How control is to be managed
- How design will be undertaken and by whom
- The methods to be used for construction
- The strategy for subcontracting and procurement
- The interfaces between the various participants
- The zones of operation and their interface
- Maximising efficiency of the project strategy with respect to cost and time
- The management of risk and opportunity (CIOB, 2011)

Having reached these decisions, scheduling is the *process* by which plans are prepared and presented to all those involved in the project. Scheduling involves answering new questions and making new decisions such as:

- When will the work be carried out?
- How long will it take?
- What level of resources will be required?

Scheduling is concerned with sequencing and timing. Sequencing and timing leads to considerations of time and cost. As more information becomes available and the project progresses, there will inevitably be a need to revise and amend such forecasts. Planning and scheduling is therefore an iterative process. A good schedule is more than simply a good graphical representation of activities and events. It must provide the basis for analysis and production. It must expose difficulties likely to occur in the future and facilitate re-organisation to overcome them. A good schedule must enable the unproductive time of both labour and machines to be minimised. It must be suitable for use as a control tool against which progress may be measured. The schedule must be sufficiently accurate to enable its use for forecasting material, manpower, machines and money requirements. It must show an efficient work method based on an optimal cost, bearing in mind the availability of the resources (Pilcher, 1992).

Having identified the differences between planning and scheduling, it is important to look at how and when these tasks are undertaken.

Planning may be an iterative process but the tasks of planning and scheduling should not be attempted concurrently. Planning should precede scheduling. Scheduling should never precede planning. It is not good practice to plan whilst scheduling. It is not a good practice to schedule whilst planning. Planning and scheduling therefore requires timing, organisation and discipline. On larger projects, where planning and scheduling will be separate tasks undertaken by different people, it is easier to differentiate between the two tasks, and the tendency to confuse the roles of planning and scheduling tasks is less likely to arise. However, for all of us it is always tempting, particularly when using computer-based tools, to start drawing up the schedule before having fully thought through the key elements, the relationships between them and the information that you wish to communicate. Avoiding this temptation will enable you to plan faster and produce better schedules.

The cost and benefits of planning

Mawdesley et al. (1997) review the costs and benefits of planning. They stress that all parties to the project can benefit from planning. The benefits for the construction client and architect/designer include:

- Established deadline dates for the release of information on the project
- The ability to forecast resource requirements and resource costs
- The ability to forecast the expenditure and payment schedules
- The ability to forecast the staffing levels
- The ability to provide information to the public and other third-parties
- Improved co-ordination of the work of the project team
- Co-ordination of the project with work on other projects within the client's/architect's portfolio

For the construction contractor the benefits include:

- Predicting the timing of activities and their sequence
- Predicting the total construction period
- Full consideration of the safety, quality and environmental impact of the construction work
- Evaluating risks and opportunities
- Providing a basis for the estimate
- Providing a basis for monitoring and control
- Predicting the contract cash flow and return on capital
- Providing a basis for claims
- Identifying when materials are required
- Minimising materials wastage
- Determining average and peak levels of materials demand
- Predicting labour, staff and plant resource levels (Mawdesley et al., 1997)

These two lists of benefits show the range of outcomes from planning that assist the main parties to the typical construction project. When committing resources to planning activities the anticipated benefits need to be carefully considered to ensure expectations meet reality. Both direct and indirect benefits need to be considered.

However, the benefits of planning may be many but they can only be achieved at a cost.

Planning requires time. Planning requires experience. Experienced planners are an expensive overhead to construction costs. To plan and communicate effectively requires a minimum commitment to computer equipment, software and technical support. (On larger projects this may extend to the provision of comprehensive information systems.) Good planning requires communication (via methods of working etc.), schedules, report, estimates, monitoring and control. These then are some of the costs of planning. They are not insignificant. Whilst the benefits of planning are widely recognised and the cost of little or no planning may be disruption, delay and late completion the issue of how much planning (and hence the cost of planning) is always a question for the project manager. Therefore, when committing resources to planning it is essential to have a clear understanding of the benefits, both direct and indirect.

Types of plans

There are three different types of plans: strategic plans, operational plans, and co-ordinating plans.

Any successful business operates under a corporate strategic plan. Many organisations have preferred suppliers and entered into strategic alliances with other organisations to operate in specific market areas or geographical regions. However, this type of planning is not the focus of this book. In this text we are concerned with project-based planning, the operational aspects of design and construction, how the design team plans and, in particular, how the construction organisation plans construction work at the pre-tender stage; the pre-contract stage; and the contract stage, including short-term planning and the monitoring of progress.

An activity of the mind

Planning is an activity of the mind. The implications of this are not always fully recognised.

It is widely accepted that planning is a task best undertaken by experienced practitioners. In the context of construction this means experienced construction professionals who have worked on a number of similar types of construction projects, ideally under different forms of contract in different geographical locations. Experts' work patterns reflect their experience. Studies of expertise in planning and scheduling reveal that experienced planners and experienced estimators work patterns are different from novices. Novices work systematically through the documentation provided. Experts work randomly in a peripatetic manner, they seek out the differences between the project under review and previous projects. Experience leads to faster conclusions but sometimes at a cost. Sometimes the solutions presented are not the optimal solution. Sometimes significant errors result and substantial additional costs are incurred when construction commences.

Ben Goldacre (2009) examined why clever people believe stupid things. He lists several traits that lead us all to wrong conclusions. These traits include randomness, regression to mean, the bias towards positive evidence, being biased by our prior beliefs, availability of information and social influences.

'Randomness' is the name given to the propensity of human beings to spot patterns where none exist. 'Regression to the mean' refers to the tendency when faced with extremes to revert to the middle view. When considering a new situation we all have a tendency to be biased towards the positive. We are also biased by our prior beliefs. (If the proposed method of working went well on the last project then inevitably we think the same method should be used on the next project.) Planners frequently suffer from lack of information and have to make assumptions. This may present changes later when new information emerges. New or different information may also present problems. All of us are often unduly influenced when information is made more 'available'. When we spot something different it tends to be given greater importance than existing information. This may unduly affect our decisions. We are all subject to social

influence of the company that we keep; ideas for new ways of working are easily influenced by the views of our peers.

Ben Goldacre (2009) sums this up as follows:

“We see patterns when there is only random noise” (p. 247)

“We identify causal relationships when there are none” (p. 247)

“We overvalue confirmatory information for any given hypothesis” (p. 248)

“We seek out confirmatory information for any given hypothesis” (p. 248)

“Our assessment of the quality of new information is biased by our previous beliefs” (p. 250)

We all need to be aware that these traits lead not only to ‘Bad Science’ but also to bad planning.

Planning for construction

Whatever the type of project under consideration, there is a need to plan. Whatever the type of project under consideration, there is a need to produce a schedule. Different industries have different characteristics. It is generally accepted that construction is ‘different’ from other industries, but how different? What is construction and what are the characteristics of construction projects?

The Oxford Dictionary (Thompson, 1996) defines construction as ‘the act or mode of constructing, a thing constructed’. In the context of the built environment and the construction industry, the term construction is widely used to include all types of work ranging from house building to commercial building, infrastructure work, civil engineering and heavy industrial engineering. The importance of the construction industry to the economy is widely recognised. In a typical developed economy the industry will contribute around 10% to the Gross Domestic Product. Within the context of planning and scheduling what is included within the term construction is not of major importance. What is important is to consider the characteristics of construction projects and how these characteristics impact the planning and scheduling process.

A construction project is widely accepted as complex in nature. This is normally due to one or all of the following factors: the physical constraints, the size of the project, technical complexity, contractual arrangements, the range of client–consultant contractor relationships and the general ‘one-off’ nature of the project. Each project is different from other projects, and the environment in which a project occurs is always different and constantly changing. Construction projects are characterised by uncertainty. Winch (2002) focuses on this aspect of uncertainty and argues that this is central to the management of construction projects. It is this uncertainty that leads to problems with respect to information and information flow:

“The management of construction projects is a problem in information, or rather, a problem in the lack of information required for decision making. In order to keep the project roiling, decisions have to be made before all the information required for the decision is available” (p. 32).

It is in this context construction that planning and the planning process need to be seen.

The planning process in the project cycle

The main objective of planning is to ensure that things happen successfully. This requires objectives to be established, tasks to be identified and progress to be monitored. The project schedule provides the basis for measuring progress, the basis for regular review and an updating of the plan.

All projects have a life-cycle. This is commonly known as the Project Cycle. This cycle comprises a number of phases (or stages) from inception through completion to operation. The exact nature of these phases, the time span of each phase and hence the total time of the life cycle will vary depending on the type of project and the industry. Compare, for example, the phases of a project to implement a new computer system: feasibility study, system selection, training and implementation, with a project for planning, designing, constructing, commissioning, operating and decommissioning a nuclear power station. The former may be completed in a few months; the latter may take 60 years.

The CIOB Code of Practice for Project Management for Construction and Development (2010a) recognises eight stages in the lifetime of a project:

- Inception
- Feasibility
- Strategy
- Pre-construction
- Construction
- Engineering services commissioning
- Completion, handover and occupation
- Post-completion review/project close-out report

Each stage represents a point where a key decision must be made.

This is not the only framework for the project process. Figure 1.1 shows the CIOB framework together with that of the:

- Office of Government Commerce (OGC)
- British Standards BS6079-1: 2000
- British Property Federation (BPF)
- Royal Institute of British Architects (RIBA)

Reviewing Figure 1.1, it is evident that each project framework contains a number of stages that commence with inception and conclude with completion. The exact number of phases and the terminology used vary with the organisation that has developed the framework.

Within this text we shall consider in more detail two of the frameworks shown in Figure 1.1: the CIOB Code of Practice and The RIBA Plan of Work. To these we have added the Process Protocol, a framework that was produced following extensive research and development with contributors from academia and industry that provides a detailed map of information flow and information requirements. We also consider the PRINCE2 methodology.

Chartered Institute of Building (CIOB)	Office of Government Commerce (OGC)	British Standards BS6079-1:2000	Construction Industry Council (CIC) Work Stages	British Property Federation (BPF)	Royal Institute of British Architects (RIBA)
1. Inception	Gate 0 strategic assessment	1. Conception	1. Brief	1. Concept	1. Preparation
2. Feasibility	Gate 1 business justification	2. Feasibility	2. Feasibility	2. Preparation of the brief	2. Concept design
3. Strategy	Gate 2 Procurement strategy Gate 3 Investment decision	3. Realisation	3. Developed design	3. Design development	3. Developed design
4. Pre-construction	Gate 4 readiness for service		4. Production	4. Tender documentation and tendering	4. Production
5. Construction			5. Installation	5. Construction	5. Specialist design
6. Engineering services commissioning			6. As constructed	6. Construction (on and off-site)	
7. Completion handover and occupation		4. Operation			
8. Post-completion review / project close-out report	Gate 5 benefits evaluation	5. Termination	7. In use	7. Use and aftercare	

Figure 1.1 The life-cycle of a project – six frameworks.

PRINCE2

PRINCE2 is a project management methodology. The name stands for: Projects in Controlled Environments. The number 2 highlights the second version of the methodology which has become the basis for all subsequent versions.

PRINCE2 was originally developed by a UK government agency for the management of Information Technology (IT) projects. As a major client for the procurement of a wide range of goods and services, the UK government clearly has a need to adopt a consistent approach and framework to project delivery, and PRINCE2 is now mandated for the management of many different types of UK government projects. It provides a structured approach to project management aimed at the efficient control of resources. The methods and their terminology provide a common language for all involved in the project. PRINCE2 adopts the following basic principles: continued business justification, manage by stages, management by exception, focus on products and tailor to suit the context of the project environment. Plans (Planning) is one of the seven key themes, along with Providing and Maintaining the Business Case, Organisation, Quality, Risk, Change, and Monitoring Progress. The methodology is based on the key stages of Starting Up a Project, Initiating a Project, Managing Stage Boundaries, Managing Product Delivery and Closing a Project. These are supported by the

processes of Directing a Project and Controlling a Stage. Planning supports all of these processes but is particularly important for Initiating a Project, Managing Product Delivery by Controlling each Stage and for Managing Stage Boundaries. Planning and producing a Project Schedule are also integral parts of Managing Product Delivery.

PRINCE2 adopts a Product-Based Planning approach requiring the user to identify all the products or project deliverables that are required if the project is to meet its objectives. The project team is required to produce: a product-breakdown structure, a product flow diagram and a work-breakdown structure (WBS). The product flow diagram typically includes multiple and complex parallel paths. This is essentially the same concept as a Precedence chart or PERT chart used for critical path scheduling. From this flow diagram the project schedule is produced. The PRINCE2 Methodology emphasises project control: an ‘organised and controlled’ start, an ‘organised and controlled’ middle and an ‘organised and controlled’ end. Each project has a Project Board comprising representatives of the ‘customers’, the ‘suppliers’, and ‘service suppliers’. The Project Manager for the project reports regularly to this Board and the main focus is the delivery of the product on time and to cost.

Further details of PRINCE2 may be found in the sources of information provided at the website for this book: www.wiley.com/go/baldwin/constructionplansched

CIOB code of practice for project management for construction and development

Within this framework there are a number of key actions. These are summarised in Table 1.1.

With respect to planning and scheduling the CIOB Code of Practice highlights the need for a project execution plan (PEP) which it identifies as ‘the core document for the management of the project’ (CIOB, 2010b).

The project execution plan, PEP

The Code of Practice emphasises that the PEP should:

‘Include plans, procedures and control processes for project implementation and for monitoring and reporting progress’. It should ‘define the role and responsibilities of all project participants’, and provide ‘a means of ensuring that everyone understands, accepts and carries out their responsibilities’. It should ‘set out the mechanisms for quality control, audit, review and feedback, by defining the reporting and meeting requirements, and, where appropriate, the criteria for independent external review (CIOB, 2010).

Essential contents of the PEP include:

- The project definition and brief
- The statement of objectives
- The business plan: with costs, revenues and cash flow projections including borrowings, interest and tax calculations
- Details of market predictions and assumptions with respect to the likely revenue and return

Table 1.1 CIOB code of practice for project management for construction and development: stages and key actions.

Stage	Key actions
1. Inception	The business decision by the client that confirms that a new facility may be required. The commissioning of a project manager to examine the feasibility of the project.
2. Feasibility	A broad ranging assessment of the feasibility of the project. This is undertaken with input from a number of experts who examine all aspects of the proposed facility.
3. Strategy	Establish the project objectives, approach and procedures. Select key team members. Check procedures for ensuring sustainability and environmental issues. Determine the overall procurement approach. Establish all necessary control systems and the means for controlling project value.
4. Pre-construction	Design Development. Principle decisions relating to time, quality and cost management. Secure statutory approvals and consents and the provision of all utilities. Provide all the necessary information for construction to begin.
5. Construction	Construct the building and/or facilities required. Control cost and time within the parameters of the project objectives. Meet environmental performance targets.
6. Engineering services commissioning	Ensure that all operational and statutory inspections and approvals have been satisfactorily completed. Ensure the provision of proper records, test results, certification etc. Arrange for advice on maintenance staff training.
7. Completion handover and occupation	Handover the building and/or facility to the client. Facilitate occupation of the building.
8. Post-completion review/project close-out report	Evaluate the performance of the project team. Identify lessons learned. A careful, objective review.

Adapted from the Chartered Institute of Building 'Code of Practice for Project Management and Construction Development' (2010).

- Functional and aesthetic brief
- Client management and limits of authority including the project manager
- Financial procedures and details of delegated authority to place orders
- A full development strategy and procurement route
- Statutory proposals
- Risk assessment
- Project planning and phasing
- The scope of content of each consultant appointment
- Reconciled concept design and budget
- Method statement for design development, package design and tendering, construction, commissioning and handover and operation
- Safety and environmental issues such as the construction design and management regulations, carbon dioxide emissions and energy targets
- Management of information systems including document management systems

- Quality assurance
- Post-project evaluation

The PEP will change during the design and construction process and therefore should be viewed as an on-going tool for review and communication. The code identifies the key role of the project master schedule (the code prefers the term ‘programme’) that needs to be developed and agreed by the client and consultants. ‘It is against this document that the project manager must monitor the progress of the project, assess risks to progress and initiate necessary action to rectify potential or actual non-compliance’ (CIOB, 2010).

Figure 1.2 summarises the code of practice perspective of the project planning required for a project.

The RIBA plan of work

The RIBA Plan of Work, first published in 1963, provides a model for the design team and a basis for managing the design and administration of the building project. It is an established framework within which the client, designer and contractor can plan and schedule their contribution to the project. Since its initial publication it has been revised and amended on several occasions.

The 2007 Plan of Work comprised five phases: preparation, design, pre-construction, construction and use. Within each of these phases there are 11 work stages (A–L). For each of these stages guidance is given as to the key tasks to be undertaken by the design team together with the outputs and the controls required (RIBA, 2007).

In 2013 the RIBA introduced a new Plan of Work. The new plan reflects the increasingly complex construction landscape including:

- UK Government Construction Strategy
- Changing procurement processes
- Need for earlier collaboration within the project team
- Improved Client Briefing
- The importance of project handover and post occupancy
- Increasing use of information management including BIM

The new plan of work comprises eight stages: Strategic Definition; Preparation and Brief; Concept Design; Developed Design; Technical Design; Construction; Handover and Closeout; and In Use. These stages are numbered 0–7.

The tasks within each stage are identified within eight task bars: Core Objectives; Procurement; Programme; (Town) Planning; Suggested Key Support Tasks; Sustainability Checkpoints; Information Exchange; and UK Government Information Exchanges.

Table 1.2 and 1.3 identify the core objectives and key support tasks at each stage. For the full details of the tasks within the eight task bars see RIBA Plan of Work (2013).

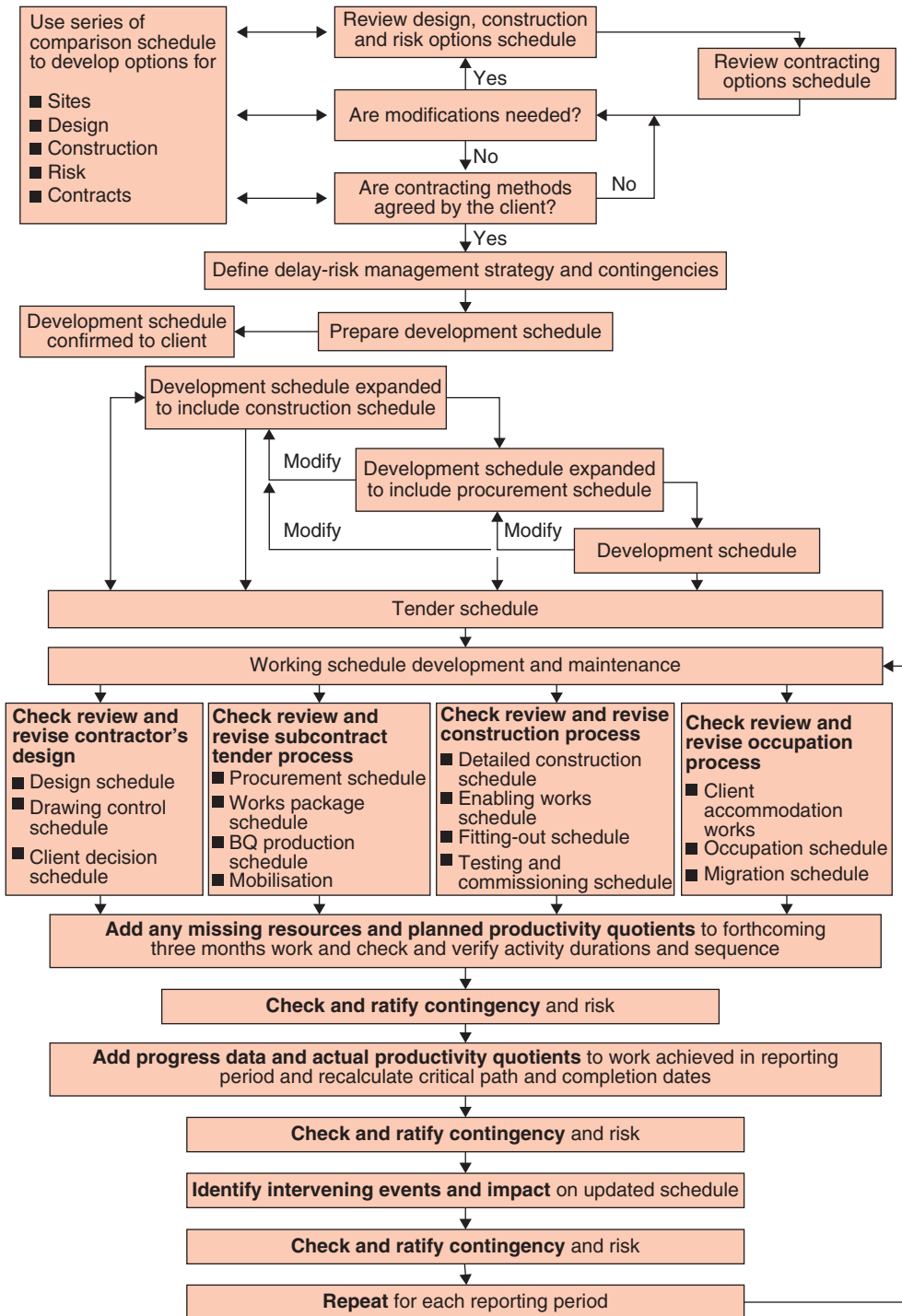


Figure 1.2 The project planning required for a project (CIOB, 2010).

Table 1.2 RIBA Plan of Work 2013, Stages 0–3.

Stage 0 – Strategic definition	Stage 1 – Preparation and Brief	Stage 2 – Concept Design	Stage 3 – Developed Design
Identify client’s Business Case and Strategic Brief and other core project requirements.	Develop Project Objectives, including Quality Objectives and Project Outcomes, Sustainability Aspirations, Project Budget, and Initial Project Brief. Undertake Feasibility Studies and a review of Site Information.	Prepare Concept Design, and preliminary Cost Information along with relevant Project Strategies in accordance with the Design Programme. Agree alterations to the brief and issue a Final Project Brief.	Prepare Developed Design, Cost Information and Project Strategies in accordance with the Design Programme.
Review Feedback from previous projects.	Prepare Handover Strategy and Risk Assessments. Agree Schedule of Services, Design Responsibility Matrix and Information Exchanges and prepare a Project Execution Plan including Technology and Communication Strategies and Standards.	Prepare Sustainability Strategy, Maintenance and Operational Strategy and review Handover Strategy and Risk Assessments. Identify any Research and Development aspects. Review and update the Project Execution Plan. Consider Construction Strategy, including offsite fabrication, and develop the Health and Safety Strategy.	Review and update Sustainability, Maintenance and Operational and Handover Strategies and Risk Assessments. Conclude Research and Development aspects. Review and update the Project Execution Plan, including Change Control Procedures. Review and update Construction and Health and Safety Strategies.

(Data Summary from RIBA, 2013).

The exact nature of these tasks and their sequencing will vary depending upon the procurement method selected. It is the aim of the new plan of work to provide a straight forward mapping and flexibility for all forms of procurement. Sinclair has produced a BIM Overlay to the RIBA Plan of Work (Sinclair, 2012).

The process protocol map

The Process Protocol Map illustrates the design and construction process in terms of the various phases of development, the main participants, the deliverables to be produced and how the process may be/is managed through a series of phase reviews. The map is applicable for a wide range of construction projects. The process is divided into ten phases covering aspects of the project lifecycle from the demonstration and conception of need to the operation and maintenance of the

Table 1.3 RIBA Plan of Work 2013, Stages 4–7.

Stage 4 – Technical Design	Stage 5 – Construction	Stage 6 – Handover and Close Out	Stage 7 – In Use
Prepare Technical Design in accordance with Design Responsibility Matrix and Project Strategies to include all architectural, structural and building services information, specialist subcontractor design and specifications, in accordance with the Design Programme.	Offsite manufacturing and onsite Construction in accordance with the Construction Programme and resolution of Design Queries from site.	Handover of building and conclusion of Building Contract.	Undertake In Use services in accordance with the Schedule of Services
Review and update Sustainability, Maintenance and Operational and Handover Strategies and Risk Assessments. Prepare and submit Building Regulations and other third party consent submissions.	Review and update Sustainability Strategy and implement Handover Strategy, including agreement of information required for commissioning, training, handover, asset management, future monitoring and maintenance and the ongoing compilation of 'As-constructed' Information.	Carry out activities listed in Handover Strategy including Feedback for use during the future life of the building or on future projects. Update the Project Information as required.	Conclude activities listed in Handover Strategy including Post-occupancy Evaluation, review of Project Performance, Project Outcomes and Research and Development aspects.
Review and update the Project Execution Plan. Review the Construction Strategy, including sequencing, and update Health and Safety Strategy.	Update Construction and Health and Safety Strategies.		Update the Project Information, as required.

(Data summary from RIBA, 2013).

constructed facility. The role of the project participants is integrated into a number of teams covering the whole supply chain. These teams are responsible for producing the deliverables of the process in terms of documents, designs or simply pieces of information. The 'gates' between the phases are categorised as 'soft' or 'hard', to distinguish when phases may commence with incomplete information and when information must be complete before the next phase may commence.

Table 1.4 shows the structure of the Process Protocol Map.

Figure 1.3 shows an extract from the Process Protocol Map.

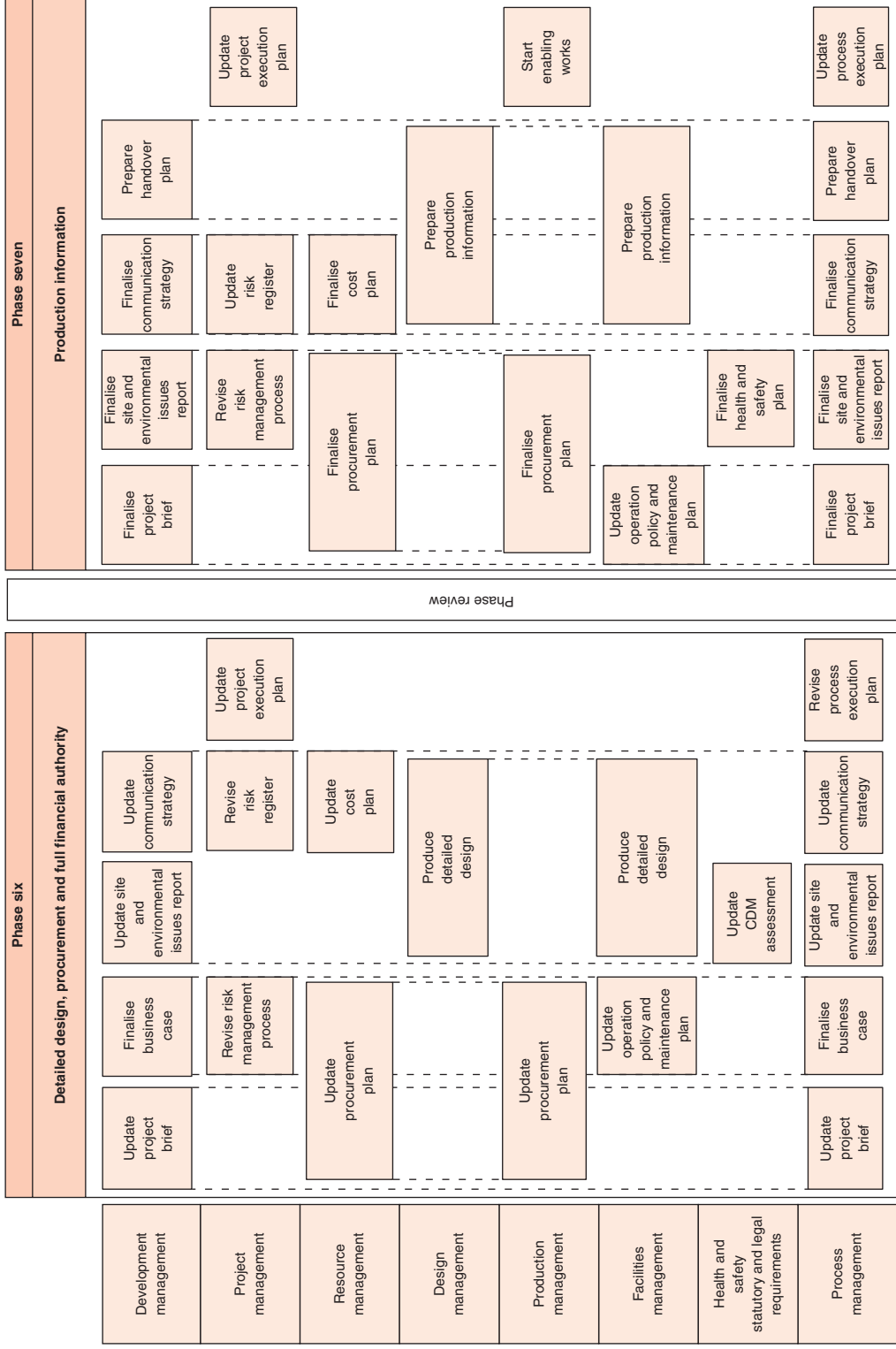
The processes within the map are sub-divided into two additional levels of detail. These provide a basis for planning and management. A key principle of the process protocol is that it may be customised to meet the requirements of specific projects and the teams involved – it is a flexible system that enables the alignment of project process with existing and new business and operational procedures (Cooper et al., 1998).

Table 1.4 The process protocol map – Overall framework.

	Phase zero	Phase one	Phase two	Phase three	Phase four	Phase five	Phase six	Phase seven	Phase eight	Phase nine
	Demonstrating the need	Conception of need	Outline feasibility	Substantial feasibility study and outline financial authority	Outline conceptual design	Full conceptual design	Detailed design, procurement and full financial authority	Production information	Construction	Operation and maintenance
Development management										
Resource management										
Design management										
Production management										
Facilities management										
Health, safety, statutory Legal management										
Process management										

The columns represent the phases of the project. The rows represent the management themes.

Section I



Phase review

Figure 1.3 Extract from the Process Protocol Map.

Summary

The CIOB Code of Practice, The RIBA Plan of Work and The Process Protocol Map all provide a framework for identifying the planning and scheduling required on a project, a basis for determining and identifying both internal and external requirements and combining these within a project master schedule. PRINCE2 provides a product-based methodology. The importance of these models is to identify different stages of the construction project and the decisions that need to be made to assist in determining how the planning will progress and how the 'diffusion of information' should lead to action and feedback. They highlight that the planning process of the construction client and the construction contractor are different. This difference is shown in Table 1.5 and Table 1.6.

Table 1.5 shows the planning process of the construction client. Table 1.6 the planning process of the construction contractor.

For individual projects the planning and scheduling requirements will also vary depending upon the form of procurement adopted by the client.

Table 1.5 The planning process of the construction client.

Project plan	Action
1. During the design stage	<ul style="list-style-type: none"> Appraise options Confirm business case Develop project strategy Prepare strategic brief Assemble team Devise risk management plan Choose procurement arrangement Risk assessments and pre-construction information Health and safety plan Commence health and safety file Prepare client programme (master schedule) Budget and cash flow Pre-qualify contractors Organise and administer tender stage Check tenders Choose preferred bid Prepare contract documents Sign contract
2. During the construction stage	<ul style="list-style-type: none"> Pre-start meeting Check bonds and Insurances Check construction health and safety Plan Contract administration Make contractor payments Monitor progress Report to the client Handover health and safety file Administer defects liability period Sign-off final account

Adapted from Cooke and Williams (2009).

Table 1.6 The planning process of the construction contractor.

Project plan	Action
1. Pre-tender planning	Decision to tender Pre-tender arrangements Site visit report Enquiries to subcontractors and suppliers Tender Method Statement Build-up estimate Pre-tender programme Build up preliminaries Response to pre-construction Health and Safety information Tender risk assessment Management adjudication Analysis of tender performance
2. Pre-contract planning	Pre-contract meeting and arrangements for commencing work Place subcontractor orders Site layout planning Construction method statement Master programme Requirement schedules Contract budget forecasts Risk Assessment Preparation and approval of the construction health and safety plan
3. Contract planning	Monthly Planning (long term) Weekly Planning (short term) Progress Reporting Cost and Value Reconciliation Report to management Review/update the health and safety plan

Adapted from Cooke and Williams (2009).

How is the planning process affected by procurement?

Procurement is the name given to the process of identification, selection and commissioning of the contributions required for the construction phase of the project (CIOB, 2011). Different forms of procurement result in different organisational and contractual arrangements. They affect what is done, by whom and when. They do not direct the planning and scheduling for construction but determine the basis for both the agreements between the parties and the process by which the project proceeds. As the project proceeds, information is required by the different parties to the contract in order that they may plan the work needed to meet their contractual requirements.

Procurement methods fall broadly into four categories:

- Traditional
- Design and build

- Management Contracting and
- Construction Management

Within each of these forms of procurement there are different variations.

Figure 1.4 shows how to select a procurement route.

The procurement route selected will be determined by the client’s perspective on a number of key considerations. The CIOB (2010) recommends that clients examine a number of factors when deciding which route to select. Table 1.7 provides an outline comparison of these different forms of procurement, considering the characteristics of procurement.

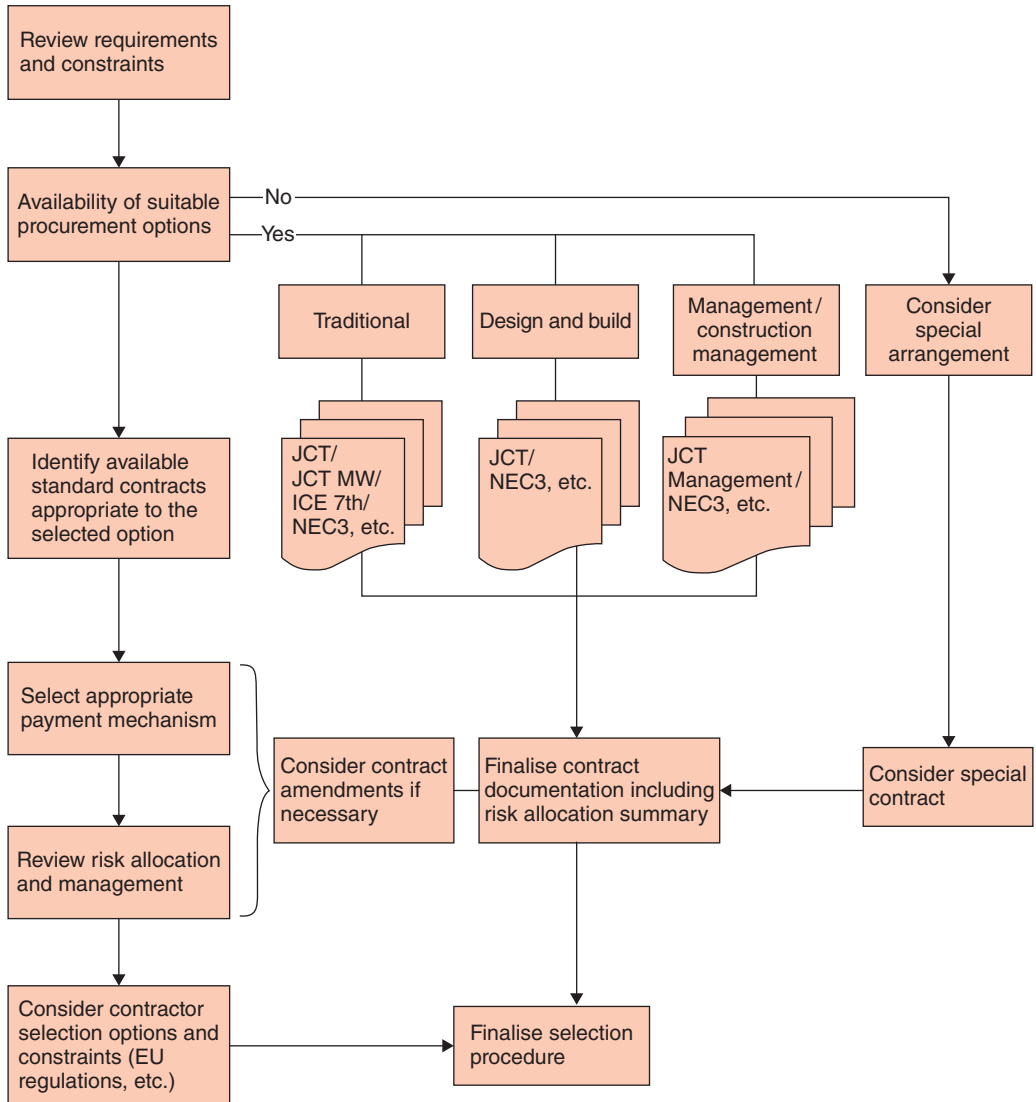


Figure 1.4 How to select a procurement route (CIOB, 2010).

Table 1.7 Characteristics of different procurement options.

Characteristic	Traditional	Design and build	Management contracting	Construction management
1. Diversity of responsibility	Moderate	Limited	Large	Large
2. Size of market from which costs can be tested	Moderate	Limited	Moderate	Large
3. Timing of predicted cost certainty	Moderate	Early	Late	Late
4. Need for the precise definition of client requirements	Yes	Yes	No	No
5. Availability of independent assistance in developing the design brief	Yes	No	Yes	Yes
6. Speed of mobilisation	Slow	Fast	Fast	Fast
7. Flexibility of implementing changes	Reasonable	Limited	Reasonable	Good
8. Availability of recognised standard documentation	Yes	Yes	Yes	Limited
9. Ability to develop proposals progressively with limited and progressive commitment	Reasonable	Limited	Reasonable	Good
10. Cost-monitoring provision	Good	Poor	Reasonable	Good
11. Input of construction expertise to design	Moderate	Good	Good	Good
12. Management of design production programme	Poor	Good	Good	Good
13. Client influence on trade contractors	Limited	None	Good	Good
14. Provision for controlling the quality of construction materials and workmanship	Moderate	Moderate	Moderate	Good
15. Opportunity for the contractor to exploit cash flow	Yes	Yes	Yes	No
16. Financial incentive for the contractor to manage effectively	Strong	Strong	Weak	Minimal
17. Propensity for confrontation	High	Moderate	Moderate	Minimal

Reproduced from Appendix 15 CIOB Code of Practice for Project Management (2010).

The forms of procurement and the range of options available to construction clients do not determine how planning and scheduling are performed but they set the context for the planning and scheduling. This is discussed in the following example. (Further sources of information on different forms of procurement and tendering procedures are included at the website for this book: www.wiley.com/go/baldwin/constructionplansched)

The context of construction project planning

Figure 1.5 is developed from a case study of a major hospital project in West London using a construction management procurement route and shows the overall planning process.

The client's project manager develops the *client's strategic programme* that drives the *tender programme* for the procurement of resource bases such as design consultants and construction manager and also the *architect's design programme*. The contractually binding agreement between the client and the construction manager is the *master programme*. The construction manager's project managers then prepare the *target construction programme* which guides the procurement of trade packages and the *parcel of documents programme* which drives the production of drawings by the architect. This last schedule is non-contractual, but can be used in claims for delays against the client caused by the non-delivery of drawings. Within the target programme trade contractors are given 'windows' for the execution of their responsibilities on site in the *tender restraints programme* and these are formally agreed in the *works contractor's programmes*. Within these programmes the trade contractors then schedule task execution at the level of the WBS that suits them. This is communicated to the construction manager in the

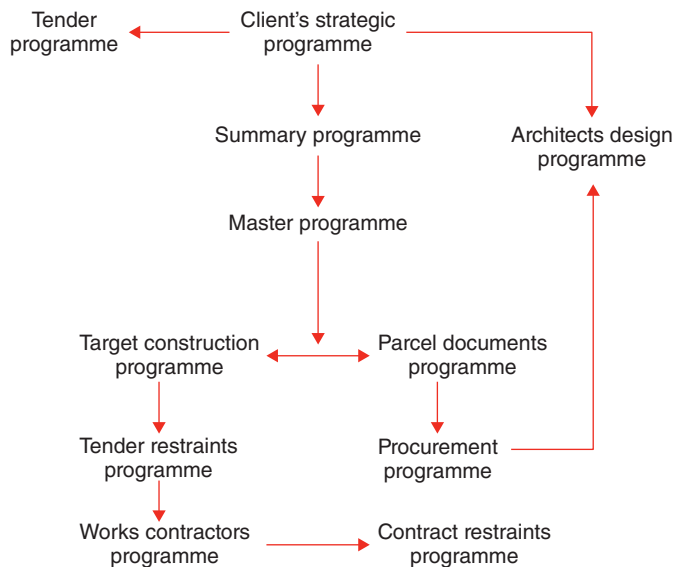


Figure 1.5 The planning hierarchy on a construction project.

contract restraints programme. In order to gain more bargaining power construction managers may or may not reveal the *master programme* to the trade contractors and provide a *target construction programme* that is significantly tighter than the *master programme* so as to buffer the completion date to ensure a satisfied client even if the *work's contractor's programme* slips behind the target completion.

This case study relates to one specific project procured under the construction management procurement process. It leads to a more general question. How does procurement impact overall industry performance?

Procurement and the performance of the UK construction industry

In the United Kingdom there has long been discussion and debate as to how the form of procurement impacts the time taken to complete the work, and the cost and quality of the construction product. This discussion and debate has extended for over 50 years.

The 1964 'Banwell Report' (HMSO, 1964) argued that existing contractual and professional conventions did not allow the flexibility required for a 'modern' construction industry. Banwell considered that change within the industry would be difficult to effect 'until those engaged in the industry themselves think and act together' (HMSO, 1964). He emphasised that 'The industry must think and act as a whole' and argued that the separation of design from construction needed to be overcome if there was going to be overall improvement in the industry and also argued that here was also a need to agree a common form of contract for building and a common form of contract for civil engineering. This it was hoped would lead to a joint form of contract for building and civil engineering works (Lord, 2008).

The recommendations of Banwell failed to introduce major change in the industry. Whilst some were willing to embrace change the majority were not. Despite initiatives by The National Economic Development Office the conservatism of the industry and 'market forces' prevailed.

At the start of the 1990s the UK construction industry was again encouraged to become more productive, more competitive and less adversarial. In 1994 Sir Michael Latham, a former Conservative MP and ex-Director of the UK Housebuilders' Federation presented a report entitled 'Constructing the Team' (Latham, 1994). Latham had been commissioned by Government to end the culture of conflict and inefficiency in the construction industry. The report was well received. It made 30 main observations and recommendations for improving the industry. The main emphasis was teamwork and the creation of working relationships where all parties benefitted. A number of recommendations had implications for the planning scheduling and control of construction works.

These included:

- Improved tendering arrangements;
- The evaluation of tenders on the basis of not only price but quality;
- The adoption of partnering arrangements;
- The implementation of proposals for productivity improvements;

- The requirement for trust funds to ensure that construction companies receive payment for the completed work;
- A wider adoption of 'Alternative Dispute Resolution' methods;
- Greater use of procurement methods such as Design and Build.

One result of the Latham Report was the formation of the Construction Industry Board. However, the introduction and adoption of these changes was slower than Latham expected.

The Egan report (1998)

In 1998 Sir John Egan presented his report 'Rethinking Construction' (Egan, 1998). This report had been prepared by a Task Force headed by Egan at the request of the Deputy Prime Minister who had requested Egan to consider the scope for improving the quality and efficiency of UK construction. In his foreword to the report Egan recognised that 'a successful construction industry is essential to all of us' and that substantial improvements in productivity and efficiency were vital 'if the industry is to satisfy all its customers and reap the benefits of becoming a world leader'. The proposals for improving performance included experience gained in other industries where the previous decade had seen considerable improvements in both productivity and the quality of the final product. The report again emphasised the role of teamwork. Through the Task Force the major clients of the construction industry committed themselves to change.

The Report identified five key drivers of change needed to set the agenda for the construction industry at large. These drivers were 'committed leadership, a focus on the customer, integrated processes and teams, a quality driven agenda and commitment to people' (paragraph 17). It set ambitious targets for annual improvements including 'annual reductions of 10% in construction cost and construction time'. It also proposed that 'defects in projects should be reduced by 20% per year' (paragraphs 23–26). To achieve these targets it recognised that 'the industry would need to make radical changes to the processes through which it delivers its projects'. It recommended that 'the industry should create an integrated project process around the four key elements of product development, project implementation, partnering the supply chain and production of components. Sustained improvement should then be delivered through use of techniques for eliminating waste and increasing value for the customer' (Chapter 3). The report stated that 'if the industry were to achieve its full potential, substantial changes in its culture and structure would be required to support improvement' and that 'the industry must replace competitive tendering with long term relationships based on clear measurement of performance and sustained improvements in quality and efficiency' (paragraphs 67–71). The report placed emphasis on the responsibilities of the construction client, stating that 'major clients of the construction industry must give leadership by implementing projects that will demonstrate the approach to construction described in the report and that clients, including those from across the public sector, should join together in sponsoring demonstration projects to make improved performance available to all the clients of construction'. It concluded, 'In sum, we propose to initiate a movement for

change in the construction industry, for radical improvement in the process of construction. This movement will be the means of sustaining improvement and sharing learning' (paragraph 84).

In 2002 Egan indicated how the proposed changes could be accelerated (Strategic Forum for Construction, 2002). Banwell, Latham, Egan. All these have emphasised the need for closer co-operation and a less adversarial way of working. Their thinking led to the emergence of Partnering as a way collaboration.

Partnering

Partnering is 'a contractual arrangement between the two parties for either a specific length of time or for an indefinite period. The parties agree to work together, in a relationship of trust, to achieve specific primary objectives by maximising the effectiveness of each participant's resources and expertise. It is not limited to a particular project' (Latham Report, 1994: 6.43).

Latham recognised that 'Good relationships based on mutual trust benefit clients' and that provided they did not become 'cosy' long term relationships between main contractors and subcontractors could improve construction performance (in terms of not only time but quality) and reduce costs for clients. He anticipated that where major work programmes were under development partnering could prove beneficial by building and maintaining construction teams. Latham proposed that 'specific advice should be given to public authorities so that they can experiment with partnering arrangements [and] where appropriate long-term relationships can be built up' (Latham Report, 1994).

Following Latham the requirement for partnering increased to become a recognised part of the construction industry's ways of working. Several large client organisations fully embraced the new ways of working to increase productivity and produce innovative solutions to the procurement and provision of new facilities and new services. This led to not only project partnering but also strategic partnering and the concept of preferred suppliers and preferred supply chains.

Where partnering is adopted for a single, 'one-off' project, this necessitates new ways of working. It is necessary to establish agreed and understood mutual objectives, determine a methodology for quick and co-operative problem resolution and develop a culture for continuous, measured improvement. Partnering features 'open book' working practices and relationships (Kirkham, 2007).

Client's requirements for contractors to adopt partnering led to new requirements for participating contractors and subcontractors. Partnering meetings facilitated by independent parties in the pre-contract and the contract phase have become a common requirement. At these meetings issues relating to identifying roles and responsibilities are discussed and agreed. Such meetings usually include representatives of all the stakeholders and extend at the pre-contract stage to cover Value Management and Risk Management.

The increased adoption of partnering (and its variants) has led to a number of new forms of contract and legal frameworks including PPC2000 (ACA, 2008) and the ICE Partnering Addendum (ICE Conditions of Contract Partnering Addendum). Where the parties do not wish to enter into a legally binding agreement but wish to create a collaborative working environment charters such as the

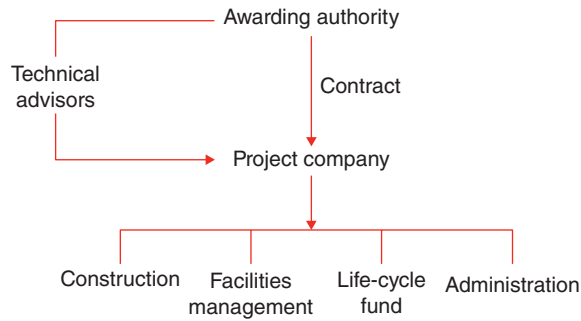


Figure 1.6 The basis of a typical PFI arrangement (Brook, 2008).

PC/N 2011 Partnering Charter (Non-Binding) developed by the Joint Contracts Tribunal may be used.

Public sector construction procurement: The private finance initiative (PFI)

The partnering approach is only one of a number of new ways of working that have emerged over the last 20 years. New forms of procurement have also emerged.

In 1992 the British Government introduced the private finance initiative, PFI. The primary objective of PFI was 'to encourage private investment in major public building projects like schools, prisons, hospitals and roads. PFI is fundamentally different to other methods of procurement in that it is exclusively used for the delivery of public buildings [and infrastructure]; and the procurement involves not only the design and the construction of the building [facility] but also the provision of services within it over a predetermined period known as the concession period. PFI is advocated as a method of risk transfer in capital procurement; the private investment implies the level of government borrowing falls and that risk is transferred from the public to the private sector' (Kirkham, 2007).

PFI (also known as Public Private Partnership, PPP) has emerged as a major form of procurement and attracted a great deal of debate. The procedures for PFI are long and complex and fall outside of the scope of this book. Figure 1.6 shows diagrammatically the basis of a typical PFI arrangement.

(Further sources of information on the different reports made on the UK construction industry are included at the website for this book: www.wiley.com/go/baldwin/constructionplansched).

Having reviewed the context in which construction planners work, this chapter ends by looking at what construction planners actually do and what is current construction planning practice.

What do construction planners do?

To answer this question Winch and Kelsey (2005) interviewed 18 planners from five leading UK construction firms. Most of these planners were currently involved in planning at the pre-tender stage including the assembly and presentation of the

tender documentation. About half were involved at the post-tender pre-construction stage. Only a few were further involved during the site works.

Generally, although a number of the interviewed planners had on-site experience the typical pattern is that a planner works either at the pre-tender, pre-execution stages or onsite but not simultaneously. The exceptions tend to be where planners work for some time on a single large project. In such cases it may make sense (from the employer's viewpoint) for their work to carry on to the execution stage.

The form of contract determined the time spent by planners on a single contract. For traditional contracting by single stage tendering the period for the preparation of the construction plan was around 4–6 weeks for larger contracts and 3–4 weeks for smaller ones. The post-tender period to the start on site date showed somewhat greater variation, from 2 to 6 weeks. For two stage tendering, the first stage was similar to the single stage tender period but it was only at the subsequent stage that a price had to be presented. However, for the planners, the time frame was similar to that of the traditional method. Those involved in two-stage planning reported that the plan was a significant factor in progressing beyond the first stage as 'a demonstration of competence' was the paramount selection criterion at this stage.

Under the construction management form of procurement planners tended to be brought into the process earlier. The principal contractors were also involved in partnered contracts and PFI schemes where the tender periods were also longer, typically 3–6 months. On large civil engineering projects the tender periods are longer, averaging 3 months. However, planners often work simultaneously on several tenders, and the actual working time available to them for preparing each tender submission is substantially less than the tender period.

Planners tend to be overwhelmed with information. They typically received large amounts of information that was not relevant to their role and spent considerable amounts of time searching through it. As might be expected, this problem particularly affected the planners working for trade contractors. The quality of the information received was poor.

The methods for dealing with the uncertainty caused by design information deficiencies were:

- Guess the missing information based on experience and past job records.
- Qualify the submitted tender.
- Assess the risk posed by the missing information and adjust the risk premium accordingly.
- Take a strict contractual stance on site with regards to negotiating the cost of variations to the tender drawings/specifications/scope of the works.

Table 1.8 presents a list of the documents produced by the planner as part of the tender team. The list shows the documents produced based upon the number of planners who mentioned their production for external (i.e. client or subcontractor) use. The interviewer specifically mentioned the first four items in the list, the rest were spontaneously mentioned by the informants.

Table 1.9 shows the domain specific knowledge that experienced planners believe enables them to solve planning problems better than inexperienced planners.

Table 1.8 A list of documents commonly produced by the planner as part of the tender team.

Documents produced by the planner as part of the tender team

Documents commonly produced

Method statement
 Bar chart schedule
 CPA
 Design schedule (for design and build projects)
 Design information procurement dates
 Procurement schedule
 Buildability schedule/value engineering options
 Quality assurance plans and procedures
 Health and safety plans and procedures

The following documents may also be produced

Resource schedules
 Phased work location drawings
 Environmental protection procedures
 Organisation charts, CVs, construction team information
 Site mobilisation plans
 Site layout drawings
 Preliminaries schedules

Adapted from Winch and Kelsey (2005).

Table 1.9 Domain specific knowledge required by planners.

Knowledge required in the following aspects of construction

Better understanding of site processes and works contractors
 Better understanding of mechanical and electrical services and co-ordination with other trades
 Development of better communication skills including listening
 Experience through working on a wide range of projects
 Better understanding of contracts and tender processes
 Development of the ability to anticipate problems
 Better understanding of 3D/spatial aspects of the work
 Development of a feel for task outputs and durations
 Better understanding supply chain management

Adapted from Winch and Kelsey (2005).

Construction planning practice: a summary

From the research of Winch and Kelsey and others, it is possible to identify the key features of construction planning practice.

Clearly, planning is a key element of construction project management. For the construction contractor planning commences with procuring the work, is a key part of the time spent before work commences on site, and continues throughout the construction process. Planning is a crucial role to play in delivering construction

project on time, to cost, safely and at the quality required by the client. Operational managers look to the planner to guide them on future work, to make forecasts on future events: what will happen and when. Senior managers look to the construction planner to measure construction process, to help prevent or at least identify potential construction problems and to ensure that claims for additional costs are supported by appropriate data.

Planning involves not only knowledge and experience of the construction process but also the ability to secure and co-ordinate information from a number of sources, both internally within the contractor's organisation and externally from numerous specialist suppliers. Planning is not a task undertaken in isolation. Planners work in a network of relationships which demand negotiating and facilitating skills and the ability to work collaboratively. Detailed planning needs to be decentralised to those responsible for the execution of the works (Ballard and Howell, 1998a; Barber et al. 1999; Faniran et al. 1999).

Construction planners have to undertake their work under the constraints of time. Often the level of information is limited and there is a need to secure and collate information before making a decision. Where no information is available assumptions need to be made. Planners need to be comfortable working in a world of uncertainty. Planning tasks may be similar from project to project but the form of procurement drives planning practice.

Key points

- Planning is the process of preparing for the commitment of resources in the most effective fashion.
- All those responsible for the management of construction work, client, designer, contractor and subcontractors, need to plan.
- Planning aims to produce a workable schedule that will achieve project goals and serve as a standard against which actual progress can be measured.
- Planning defines what should be done, the activities that should be performed, when they should be performed (the sequence and timing), the methods of operation, who should perform each activity and with what resources and equipment.
- The main objective of planning is to ensure that things happen successfully. This requires objectives to be established, tasks to be identified and progress to be monitored.
- Planning is characterised by the volume of information available to the planner and the uncertainty relating to the information available.
- Planning is a mental activity and as such is subject to the influences of the human psychology.
- Scheduling is the process of quantifying the programme and the production of calculated dates and logic. It covers all aspects of the production of bar charts, networks, method statements and other material relating to the project.

- Different institutions have produced different models for identifying the different phases of a construction project. The importance of these models is to identify within a common framework the different stages of the construction project and the decisions that need to be made to assist in determining how the planning will progress.
- The form of procurement and the range of options available to construction clients set the context for the planning and scheduling and determine the form and provision of information to the client and the other stakeholders.
- New forms of procurement such as PFI and new ways of working such as Partnering have extended the role and tasks of the construction planner.