



Management of a Construction Project 9

Getting to know your unit

Assessment

You will be assessed by a series of assignments set by your tutor.

The four major functions of managing a construction project are planning, organising, leading and controlling. Effective management of a construction project will ensure that it is completed successfully in terms of safety, time, cost and quality. To achieve this, the project must be properly planned, organised, led and controlled. The construction industry has a poor record in terms of completing on time and on budget. Recent reports have attempted to address these issues within the construction industry.

This unit will help you to understand management principles, techniques of the planning process and the importance of information technology in quality assurance and control of a project. You will learn about the roles of individual team members and the techniques applied by a site manager to manage a project successfully. You will understand purchasing and cost management techniques, and consider the methods used to plan and control a programme of works for a construction development.

How you will be assessed

Throughout this unit you will find useful assessment activities that will help you towards your final assignments. Completing these assessment activities will not necessarily mean that you achieve a particular grade, but they will help you to carry out relevant research or preparation that can be used towards your final assignments.

To ensure that you achieve all the tasks in your set assignments, it is important that you cover all the Pass criteria. Make sure that you check each of these before you submit your work to your tutor.

If you want to achieve a Merit or Distinction you must consider how you present the information in your assignment and make sure that you extend your responses or answers. For example, to achieve a Merit (M1) you must discuss the roles of members of the construction management team and how their individual responsibilities are applied. To achieve a Distinction (D1) you must further evaluate the different roles of the construction management team, their responsibilities and the techniques applied by a site manager to manage the project.

The assignments set by your tutor will consist of tasks designed to meet the criteria in the table on the next page.

They are likely to consist of written assignments that:

- ▶ explain the roles and responsibilities of each of the members within a project management team
- ▶ explain the cost management techniques used to monitor the profitability of construction projects
- ▶ produce a graphical master programme for a given construction project and explain the methods used to monitor the progress of the project.

Assessment criteria

This table shows you what you must do in order to achieve a **Pass**, **Merit** or **Distinction** grade.

Pass	Merit	Distinction
Learning aim A Understand the principles and application of management in construction		
<p>A.P1</p> <p>Explain the roles of the members of the construction management team and their individual responsibilities.</p> <p>A.P2</p> <p>Explain the techniques applied by a site manager to manage the project.</p>	<p>A.M1</p> <p>Discuss the roles of the members of the construction management team and how their individual responsibilities are applied.</p> <p>A.M2</p> <p>Discuss the techniques applied by a site manager to manage the project.</p>	<p>A.D1</p> <p>Evaluate the different roles of the construction management team, their responsibilities and the techniques applied by a site manager to manage the project.</p>
Learning aim B Understand purchasing and cost management techniques		
<p>B.P3</p> <p>Explain the methods used by construction companies to facilitate the supply of appropriate materials to site.</p> <p>B.P4</p> <p>Explain the cost management techniques used to monitor and control the cost and profitability of construction projects.</p>	<p>B.M3</p> <p>Assess the methods used to facilitate the cost-effective supply of appropriate materials to site.</p> <p>B.M4</p> <p>Analyse the cost management techniques used to effectively monitor and control the cost and profitability of construction projects.</p>	<p>B.D2</p> <p>Evaluate the methods used to facilitate the ethical supply of appropriate materials to site, meeting programme requirements, and how these impact on the cost management and profitability of construction projects.</p>
Learning aim C Develop a programme of activities for construction works		
<p>C.P5</p> <p>Produce a programme of activities with graphical representations for a given construction project.</p> <p>C.P6</p> <p>Explain the methods used to monitor the progress of construction projects.</p>	<p>C.M5</p> <p>Produce a detailed programme of activities, with graphical representations and appropriately detailed timings for a given construction project, and consider an appropriate method to monitor progress.</p>	<p>C.D3</p> <p>Produce a comprehensive programme of activities, with graphical representations and highly detailed timings that show critical and non-critical elements for a given construction project, and consider the most appropriate method to monitor progress.</p>



Getting started

The success of any construction project depends on how well the project management team plan, organise and control resources such as plant, labour and materials to ensure the project is completed safely, to the required quality, on time and on budget. Spend a few minutes researching on the internet to compile a list of major construction projects which have been completed in recent years. Now select a project of your choice and investigate whether the project was completed on time and on budget.

A

Understand the principles and application of management in construction

A1 Principles of management

Key term

Management – the process of organising or controlling things or people.

Management style, methods and theories

For construction projects, effective **management** makes the best possible use of the resource materials, plant, labour and finance to complete the project safely, on time and on budget.

The main management styles are:

- ▶ **Autocratic:** managers make all the decisions with little input from the team. This can be good in a crisis but can demotivate staff if they have no direct involvement in decisions and do not feel valued.
- ▶ **Laissez-faire:** managers delegate the responsibility of decision-making to the team.
- ▶ **Participative (democratic):** managers value the group's input but the final decision rests with them. This often boosts employee morale because they feel they are part of the decision-making process.
- ▶ **Transactional:** managers provide rewards or punishments to team members based on results.
- ▶ **Transformational:** managers motivate employees and increase output and efficiency through good communication, constant presence and regular expressions of appreciation.

Fayol's 14 principles of management

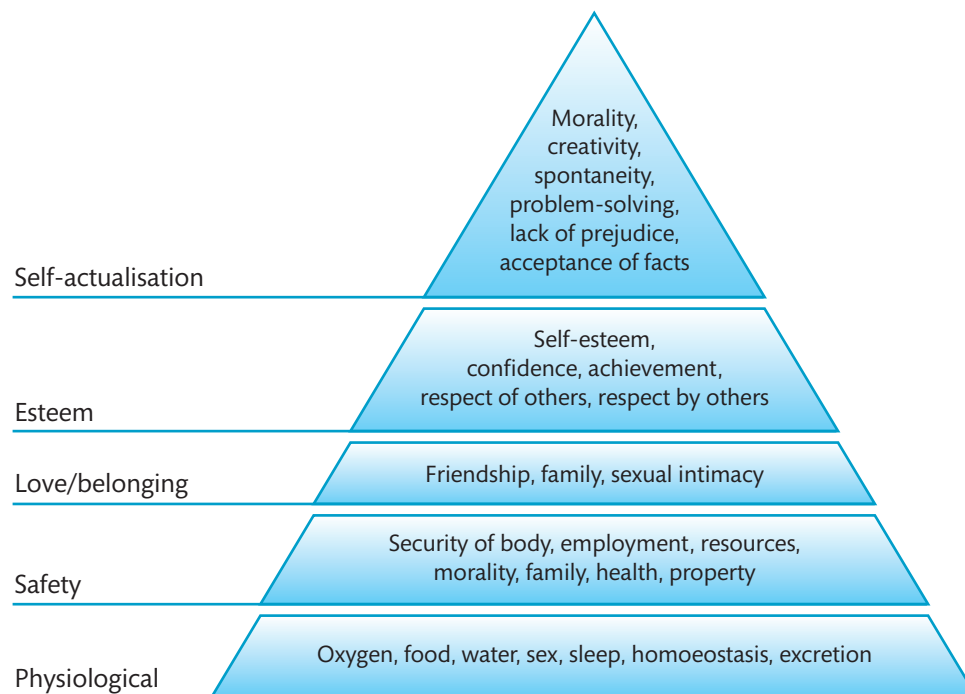
Henri Fayol was an engineer who worked in mining in France in the 19th and early 20th century. During his working life managing the mines he became aware of the importance of management principles. He published a book containing 14 principles of management. It is regarded as one of the first and most respected theories of management. His 14 principles are:

- 1 Division of work – workers with specialist skills become increasingly skilled and efficient, which can increase output.
- 2 Authority – while managers must be allowed the authority to give orders, they must be aware of the responsibility that comes with authority.
- 3 Discipline – there are many ways to maintain discipline in a working environment.
- 4 Unity of command – workers should have no more than one direct supervisor.
- 5 Unity of direction – work can only be well co-ordinated if teams with the same objective use a single plan and work under the direction of a single manager.
- 6 Subordination of individual interests to the general interest – the team as a whole is more important than the interests of one worker, including the manager.

- 7 Remuneration – fair financial and non-financial compensation is likely to lead to satisfied workers.
- 8 Centralisation – the decision-making process should be balanced in terms of worker involvement.
- 9 Scalar chain – workers should be clearly positioned in the business's hierarchy.
- 10 Order – workplaces and their facilities must be clean, tidy and safe.
- 11 Equity – managers should always act fairly to all their workers and maintain discipline in an even-handed way.
- 12 Stability of tenure of personnel – managers should try to minimise worker turnover.
- 13 Initiative – workers need to have the appropriate freedom to create and carry out plans of work.
- 14 Esprit de corps – organisations should promote team spirit, loyalty and unity.

Maslow's hierarchy of needs

Abraham Maslow was a psychologist working in the middle of the 20th century. He was primarily concerned with the human side of business and believed that all management styles are based on psychology. He wanted to determine what motivated people and, by understanding this, help businesses to motivate their staff to improve productivity. His pyramid model shows our main motivators as humans, starting from essential physiological requirements like breathing, water and food, and keeping ourselves safe. Once these aspects are in place, our motivations change to requiring love and a sense of belonging, then to elements of esteem such as confidence and mutual respect. Only when these motivations have been fulfilled can we start to consider self-actualisation, which covers creative and philosophical aspects of life. Figure 9.1 illustrates this. In the context of work, managers need to understand what might motivate their staff and how to provide these motivations.



► **Figure 9.1:** Maslow's hierarchy of needs

McGregor's X-Y Theory

A social psychologist working in America, Douglas McGregor, proposed the X-Y Theory in his 1960 book *The Human Side of Enterprise*. He suggested that there are two main methods of managing people:

Discussion

Discuss the different models and styles of management and identify the strengths and weaknesses of each. Which style do you believe might be most suited to a construction project?

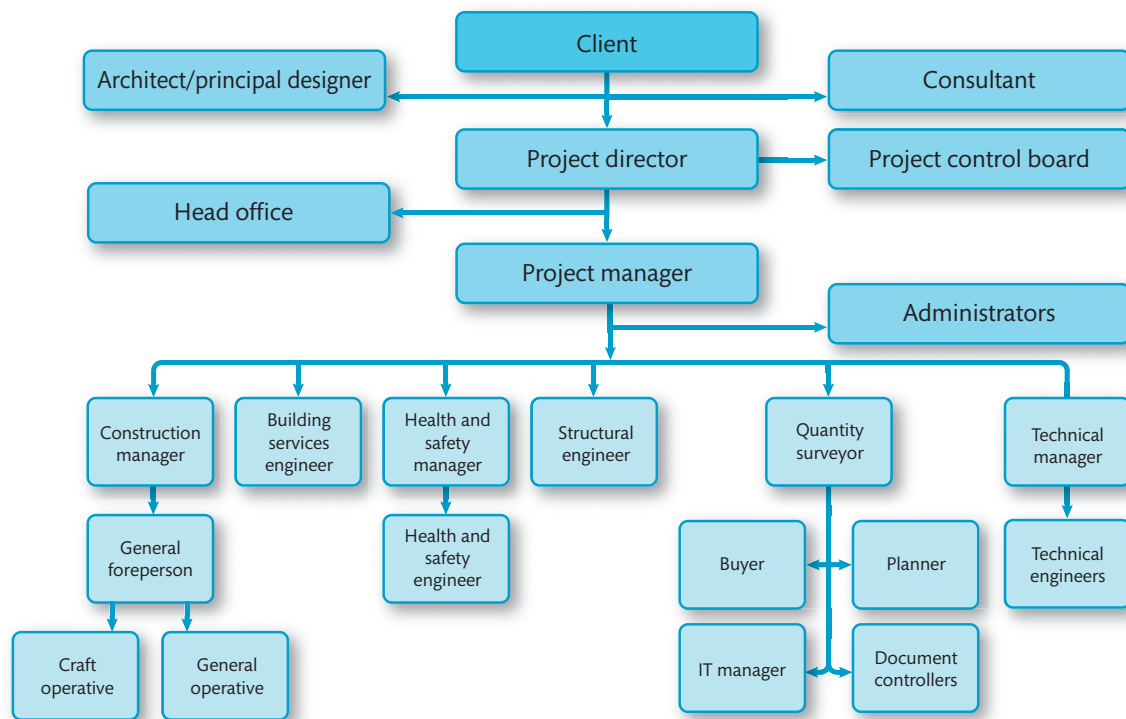
- ▶ Theory X – authoritarian management style – states that employees dislike work, avoid responsibility and need to be directed.
- ▶ Theory Y – participative management style – states that employees are motivated by job satisfaction and are keen to take responsibility.

Managers who opt for Theory X generally get poor outcomes, while managers who engage Theory Y often produce more motivated staff, resulting in better productivity and profitability.

Roles, responsibilities and interaction of a construction project management team

Construction projects involve a wide range of professions and the project team may change throughout the project. A number of key team members will be in place from concept to completion, whereas other specialist professions will only be involved for short periods of time.

It is crucial that the correct structure is put in place from the start of a project to ensure its success. Figure 9.2 shows an example of a hierarchical structure that might apply to a particular construction project.



▶ **Figure 9.2:** Example of project management structure for a construction project

Table 9.1 shows the typical roles of people working on a construction project.

▶ **Table 9.1:** Typical roles on a construction site

Project team role	Description
Architect	<ul style="list-style-type: none"> • Usually the client's representative and may be called the principal designer for the purposes of the CDM Regulations. • Divides their time between office and site, communicating with the client and the project team. • Responsible to the client for planning, managing, co-ordinating and monitoring all the design duties during the pre-construction phase and then liaises with the principal contractor to help in the planning, managing, monitoring and co-ordination of the construction phase. • Involved at each stage of the construction process.

▶ **Table 9.1:** *Continued ...*

Project team role	Description
Quantity surveyor	<ul style="list-style-type: none"> Responsible for the financial planning of the project. Deals with all financial aspects such as payments for supplies, invoicing, claims for variations, etc. Deals with cash flow and plans periods when payments for the work undertaken are made.
Construction/Site manager	<ul style="list-style-type: none"> Responsible for all operations on site, although they may delegate to general forepersons controlling specific trade areas on the site. Concerned with day-to-day planning, organisation and control of the site, including organisation of resources. Ensures the project is delivered safely, on time, on budget and to required quality by carefully managing resources to maximise production and minimise wastage. Arranges efficient disposal of waste, recycling (where possible) and arranges subcontractors.
Project manager (PM)	<ul style="list-style-type: none"> Has overall responsibility for planning, organising and controlling the project from concept to completion. Requires a wide range of skills such as identifying problems early, resolving conflicts and clearly communicating the client's objectives and vision to the team. Must perform effectively within tight timescales and keep within strict budgets while maintaining a positive team dynamic.
Structural engineer	<ul style="list-style-type: none"> Responsible for the design and physical integrity of the building to ensure safety and durability. Structural engineers solve design challenges and help the architect achieve their vision.
Building services engineer	<ul style="list-style-type: none"> Also known as mechanical and electrical engineers (M&E). Responsible for installing and maintaining systems in buildings to make them comfortable, efficient and safe. For example: energy supply, lifts, fire safety, heating, ventilation and air conditioning (HVAC), ICT networks, plumbing, etc.
Buyer	<ul style="list-style-type: none"> Responsible for purchasing and ensuring timely delivery of materials and plant to the site. Analyses the main contract to obtain a set of delivery dates for materials. Often places a bulk order with a supplier, who delivers specific quantities to the site when requested by the site manager.
Planner	<ul style="list-style-type: none"> A technical role, usually responsible for supervising contract programmes, monitoring and reviewing progress; scheduling materials delivery, plant and labour; reporting procedures and overseeing pre-contract tender documents. Has an overview of the project and reports on progress to the architect or project manager. Expected to plan to make efficient use of resources, including working out how many operatives will be required; supplying buying section with materials schedules of what is required, when and how much; moving plant and machinery on and off site when required.
General foreperson	<ul style="list-style-type: none"> Reports to the site manager or supervisor and is often trade specific, for example brickwork foreperson. Assists the site supervisor with labour control, materials control and some of the trade-specific plant.
Craft operative	<ul style="list-style-type: none"> Trade worker with a craft background, such as joiners, bricklayers and steel fixers. Responsible for producing work of the correct quality. Contributes to maintaining the construction programme. Has a duty under health and safety legislation to work safely.
General operative	<ul style="list-style-type: none"> Undertakes semi-skilled works, such as excavation of drainage trenches, working with concrete, keeping the site clean and seeing to the movement of resources.

Key terms

Variations – items that were not in the client's original budget and therefore are additional to the contract, such as changes to the design or additional quantities of material not in the original contract.

Cash flow – the amount of money flowing into the company from the client and out of the company as payments, for example salaries and payments for materials. Money flowing in should be greater than money flowing out.

Planning and forecasting a project's needs, requirements and resources

Link

See Unit 2: Construction Design, section A1, for more about the RIBA Plan of Work 2013.

See Unit 5: Health and Safety in Construction, section A2, for more about the Construction (Design and Management) Regulations.

Key term

Snagging – the process of checking a new building for defects and rectifying the faults to comply with the client's requirements.

Planning the requirements for a construction project is a fundamental element in its successful management. It involves choosing the design, establishing specific work activities, estimating the resources required, predicting the length of time needed to complete each task and identifying links or overlaps with any of the activities. A good construction plan enables an accurate cost and time for completion to be established.

The plan often starts with the finished project and works backwards to initial site work. This enables the project team to identify specific activities involved in the construction of the project, and how they impact on other activities. They can identify any possible clashes or problems, so that they can accurately determine the most suitable plan and organise the required resources when necessary.

Every construction project has unique requirements or design features, but resources can generally be categorised in the same way: materials, labour, plant and finance.

On-site, short-term management for projects in progress

Table 9.2 lists the four phases of construction, and provides a brief overview of what happens and who is responsible for each phase.

► **Table 9.2:** Phases of a construction project

Phase	Management tasks
Pre-construction	<p>The client appoints a principal designer to manage the pre-construction phase of a project involving more than one contractor, in line with the Construction (Design and Management) Regulations 2015.</p> <p>The principal designer must:</p> <ul style="list-style-type: none"> • plan, manage, monitor and co-ordinate health and safety in the pre-construction phase • advise the client on the pre-construction information, and provide this information to the project • ensure everyone involved in this phase communicates and collaborates effectively • communicate with the principal contractor any risks to be controlled during the construction phase. <p>The principal designer produces the detailed client brief for the project team, which provides the pre-construction information required under the CDM Regulations. The principal contractor must prepare the construction phase plan for the project.</p>
Site preparation	<p>The construction/site manager is responsible for this phase. They manage the clearing of the site, marking out of foundations, and designate the position of site office and storage of materials on site, as well as co-ordinating the human resources, plant and materials required for tasks undertaken during this phase.</p>
Construction	<p>During this phase, the principal contractor is responsible for the site and all the work taking place on site. Often the principal contractor will appoint specialist subcontractors to carry out specific elements of work such as foundations, steelwork, brickwork, joinery, roofing. Under the CDM Regulations the principal contractor must make sure adequate welfare facilities are provided.</p>
Handover	<p>The RIBA Plan of Work 2013 Stage 6 – 'Handover and Close Out' – describes handover strategy, commissioning (testing of services etc.), training of staff and other activities that are vital for the successful operation of the building. The 'as constructed' information will be updated with information from the specialist subcontractors and the principal contractor.</p> <p>This stage will also include the defects liability period (snagging) which may be 6 to 12 months. The final certificate will be issued at the end of this period.</p>

II PAUSE POINT

Briefly outline what is involved in the four stages: pre-construction, site preparation, construction phase and handover.

Hint

Think about the differences between each stage.

Extend

Explain how each stage follows on from the previous stage. Which team members are likely to have responsibilities at different stages?

Claiming interim payments

During a construction project, the contractor asks the client to make interim payments at stages or milestones throughout the building process, based on the value of work completed. A quantity surveyor carries out an interim valuation of the work that has been completed and recommends a value to the architect or designer representing the client, who issues an 'interim certificate' to the client as authorisation for payment.

Managing cash flow

For a building project to be successful it is vital there is appropriate financial planning and control to prevent the project running over budget. Cash flow management is the organisation of the money coming in and out of the company. Good cash flow management ensures there are sufficient funds to meet the needs of the company. Poor cash flow management can create a loss in profit and may even lead to the company going bankrupt. It is important to chase up payments due in good time, and to be aware of the outgoing and incoming payments due at different stages of the project. All changes to forecast costs should be recorded.

Research

Research construction projects that may have run over budget. Investigate the possible causes for the increase in budget and list the top five reasons.

Order and delivery of materials

Materials are the physical resources used to construct the building. Materials supply must be linked with the **construction programme** for the project to avoid delays. It is important that:

- ▶ the correct quantity of material is ordered (e.g. correct number of bricks or blocks)
- ▶ the material ordered is the required quality (concrete is the required strength, e.g. 30N/mm²)
- ▶ the best value for money is achieved – balance of price and quality
- ▶ the materials are delivered and available at the required time.

A materials schedule is a list of the necessary materials for the job and the time they are needed to comply with the construction programme. The principal contractor completes the schedule before work starts to ensure materials are delivered on time.

The site manager needs to record and keep records of any materials delivered. They should carry out checks to ensure these meet the required specification for quantity

and quality. Any damaged or incorrect materials should be returned to the supplier immediately. All records relating to the delivery of the materials should be passed to the accounts manager so they can check the quantities supplied against the invoices received.

Key term

Construction programme – the sequence in which the various tasks will be carried out during the construction project to enable it to be completed on time.

Labour requirements and training needs

Link

More information about subcontractors and labour requirements can be found in Unit 3: Tendering and Estimating, in section B3.

More information about training labour and general site health and safety can be found in Unit 5: Health and Safety in Construction, section A6.

Labour is one of the key elements for a construction project. The labour requirements for any project must therefore be properly planned and costed well in advance of work starting and must link with the construction programme. The availability of labour depends on a number of factors:

- ▶ expected and reasonable pay rates
- ▶ government policy on spending on infrastructure and housebuilding
- ▶ training and upskilling of the workforce
- ▶ developments in technology
- ▶ location of the work
- ▶ skills needed for the project – for example, workers who know traditional building techniques or more modern methods.

The principal contractor completes a labour schedule listing the labour required throughout the project, including the number of operatives required for each activity. They should identify skilled tradespeople and specify whether they are directly employed or are subcontractors.

Maintaining skilled labour is important to ensure a high quality of work. Training is essential to maintain and upskill the workforce, and can help to motivate the workforce. A training needs analysis (TNA) will allow the company to get an accurate assessment of the type and amount of training needed.

It is essential that all the companies and employees (including subcontractors) involved in any and all stages of the project are aware of the health and safety legislation that applies and the need to adhere to it.

Key terms

Plant – machinery used for a construction activity, such as cranes, concrete mixers, excavators, loaders, forklifts, bulldozers and mobile elevated work platforms (MEWPs).

Contract – a written or spoken agreement between two or more parties where there is a promise to do something (such as work) in return for a benefit (such as money).

Plant requirements

The main purpose of using **plant** on site is to increase productivity and reduce labour costs. The plant required for the project depends on factors such as size and location of the site (for example, whether it is a restricted city-centre site or an open area), the extent of the work carried out and the cost. As with materials and labour, management of plant is critical and must be scheduled to link with the construction programme to maximise output and minimise costs. All drivers and users of plant must be fully trained and hold the appropriate qualifications and CSCS card.

Quality assurance and control

Quality assurance (QA) is an administrative process to prevent defects and failures and provide confidence to clients. Defects and failures during the construction process can result in delays and increased costs or disputes. QA aims to ensure that the building will be fit for purpose, built on time and within budget. It requires regular monitoring of the planning, design, specifications, contracts, construction and maintenance, and the links between these activities.

The main decisions relating to the quality of a construction project are made during the design phase rather than during the construction phase. At the design phase, material specifications and construction methods are planned to minimise issues that might arise during the construction phase. During the construction phase, QA involves ensuring the original design and specifications are followed, such as testing materials to ensure the quality is acceptable.

Workforce supervision

The workforce is one of the principal resources of a project and must be properly managed to ensure the project is completed to time, budget and quality. A workforce needs good leadership and supervision. It may contain employees of the company as well as staff from subcontractors, all of whom must be brought together into a productive group. It is important that any supervisor is competent and has the respect of the workforce. Good communication is an essential part of workforce supervision to ensure that all involved in the workforce understand what is required.

Decision-making

Making decisions is an integral part of a manager's job. A decision is an outcome and should be arrived at after careful consideration of all the available information. There needs to be a clear process for making decisions to avoid mistakes, accidents or failures. Everyone on the site needs to know what decisions they can make, and who to escalate problems to. This is where an organisational chart can help.

Managing unforeseen events

An unforeseen event could not have been predicted or anticipated, such as extreme weather conditions, fire, clients re-briefing the design or a subcontractor going out of business. In such circumstances, a contractor or subcontractor may demand compensation if they believe the events they encountered could not have been foreseen or were not part of the original tender or design. If the original **contract** is unclear, has insufficient detail or has not made allowance for unforeseen events, this can lead to disputes and delays which impact the project as a whole.



PAUSE POINT

What are the key resources for any construction project? Briefly outline the requirements of each resource for a construction project.

Hint

Think about each resource individually.

Extend

Explain how each resource is required at different stages of a construction project.

To manage unforeseen events, it is important the project team understands the client's exact requirements. These should be clearly and regularly communicated to the team. The project team need a process to look at claims independently while work continues. The client may need to keep a **contingency allowance**.

Handover schedule

The handover schedule is part of Stage 6 of the RIBA Plan of Works 2013. The aim of the project management team is to complete the project to the required standard so the client accepts ownership of the project. This will involve commissioning the building services of the project. This commissioning or handover period may last for 6 to 12 months and include customer training. During the handover period, other activities need to take place, such as compiling the documents and drawings for the health and safety file.

Under the CDM Regulations, the principal designer is responsible for preparing the health and safety file. The file is handed over to the client at the end of the project and must contain any information needed in relation to health and safety issues during any further work on the structure such as maintenance, conversion, adaptation or demolition (see Unit 5: Health and Safety in Construction, section B3). There will also be an agreed period of time for identifying and rectifying faults and defects.

Completion

Stage 7 of the RIBA Plan of Works 2013 is entitled 'In use'. This is the final stage and includes the completion of the activities in the handover strategy. It also includes updating the project information in response to continuous client feedback until the end of the building's life.

Managing the organisation's viable options

National and local policies, trends

Approximately two million people are employed in the construction industry, which closely follows the economic trends of the country. For example, during the economic recession in the late 2000s, the industry was hit hard, with high job losses due to a lack of investment in building. The UK is still recovering and spending on infrastructure and housing has been restricted as the government looks to reduce the country's **debt** and **deficit**.

The government has set a target of building 200,000 new homes a year. Over the last decade, the construction industry has failed to reach this target for a number of reasons such as planning issues, recession, **land banking** and a lack of available land for development. Local planning authorities have encouraged the development of brownfield sites and simplifying the planning system to try to boost the number of houses being built.

To improve the technology used in the construction industry the government has required building information modelling (BIM) to be used on large public sector projects. BIM allows all the different team members to communicate information with each other with the benefits of improved productivity, reduction in faults and reduced construction time and cost.

Labour requirements, recruitment, investment in skills and training

According to the Construction Industry Training Board's (CITB's) Construction Skills Network (CSN) forecasts for 2016–2020, the construction industry may create 230,000 construction jobs throughout the UK. During the recession, employers cut staff to a minimum and provided only limited training, and the numbers of apprentices fell drastically, all of which contributed to the lack of skilled workers available now. Employers are now finding it hard to recruit staff with the right qualifications and

Key terms

Contingency allowance – a percentage of the cost set aside to deal with resolving unforeseen events.

Debt – amount of money owed.

Deficit – the negative difference between spending and income.

Land banking – when developers buy up available land but do not build on it.

Discussion

As a group, discuss possible unforeseen events that may occur during a construction project. Compare these events to possible defects, which may be identified during the handover stage. Discuss who might be responsible for the cost of the remedial work and why.

Research

Search on the internet to find the government's strategy paper 'Construction 2025'. Who did the government work with to create this paper? What does the government wish to achieve? Find four key targets that are set out in the strategy paper.

Link

For more about BIM, see Unit 7: Graphical Detailing in Construction, section A2.

experience and this is set to get more difficult as demand rises. With an ageing workforce and lack of young people the industry faces a critical skills shortage.

The government, employers and training providers must work together to attract young people of the right calibre into the industry. These industry leaders must provide a clear progression pathway to allow professional development and create an attractive career.

The industry also needs to improve its recruitment of women. Currently women make up only about 10 per

cent of the total workforce. The industry has much to do to improve its image and promote the positive aspects of a career in construction if it is to attract the number of young people it requires to meet the current skills shortage.

Subcontract or direct employment

It is unusual for a construction company to undertake all the tasks involved in a project using just its own staff. Table 9.3 captures the relative benefits of using direct employees and subcontractors.

► **Table 9.3:** Benefits of using direct employees and subcontractors

Benefits of direct employees	Benefits of using subcontractors
<ul style="list-style-type: none"> • Cheaper daily rates than subcontractors. • Enables more control over staff. • Ensures the quality and training of staff is suitable. • Staff should be more motivated and committed, leading to fewer disputes and discipline issues on site. 	<ul style="list-style-type: none"> • Enables the use of specialist skills such as plumbers, electricians, fire and security alarms systems, flooring, etc. • Can be called in to carry out tasks as and when required, so a company does not have to employ them full-time, saving money. • They supply and maintain their own equipment, saving costs to the company. • The company is not responsible for the wages of the staff, holiday pay, sick pay or pension contributions.

The most successful solution is usually to have a small reliable team of directly employed staff on site to work alongside the subcontractors. This helps to ensure that the company's policies and procedures are followed and reduces the number of defects or faults encountered.

Site management structure

The management structure on a construction project will depend on the size of the project. For a project to be successful, the project team must work collaboratively to overcome design changes and unforeseen events. A company can use two main site management structures:

- Fully site-based – for large projects the project team may all be based on site. A principal contractor is on site at all times and they will be in regular contact with the rest of the project team overseeing the progress of the project. Regular site meetings will ensure everyone involved is clear on what work has to be carried out and able to raise any issues.
- Head office-based functions and support – most small to medium-sized construction projects will operate in this way. The principal contractor on site will have access to a range of company resources, which will be available at the head office. Often the company may be operating several sites and therefore it is cost-effective to centralise these resources.

Plant and equipment hire, lease or purchase

Plant and equipment are a principal resource for any construction project and must be effectively managed to maximise their use and minimise costs. For most

construction projects of a short duration (16–20 weeks) it is more cost-effective to hire plant than to purchase it outright, as plant is expensive and the company may not need to use it again once the project has been completed.

Leasing plant is similar to hiring, but involves an agreement with a finance company. The contractor hires the plant for a number of years, usually three, and pays rent for it every week or month. Sometimes there are restrictions, for example the number of miles the contractor can use the equipment per year, and it is often difficult to end a lease agreement early.

Purchasing for long-term contracts or large companies is sometimes the most efficient option. The company needs to establish if it will make full use of the equipment; leaving it to sit idle for long periods is not cost-effective. Before deciding to purchase equipment, the company will need to ask some questions:

- How will the purchase be paid for – through a bank loan or from the company's profits?
- How much maintenance and servicing will the equipment require and what are the likely costs?
- Will an operator need to be trained to use the equipment?
- How much will the equipment depreciate per year?
- What percentage productivity a year will the equipment achieve?

Discussion

Discuss the advantages and disadvantages of various options available for obtaining plant and equipment for a construction project.

Organising, procuring, co-ordinating and controlling

Materials, plant and equipment delivered to site on time

The principal contractor is responsible for organising, procuring, co-ordinating and controlling materials. The availability of materials has become a problem in recent years, as suppliers no longer carry high stock levels. This is because materials standing in their yard or warehouse tie up too many financial resources. Many specialised materials are made to order and can take many months to be delivered. This needs to be considered during the planning stage and may mean the client pre-purchasing a material and including a provision in a tender document, so that when the material does arrive the contractor is paid for handling, storage and delivery.

The availability of space for storage, the rate of work, the distance materials have to travel and the reliability of the supplier are all factors to be considered when planning a delivery schedule. Good organisation can reduce the amount of waste (and therefore save money) by planning delivery dates and quantities which link with the construction plan and use available storage on site.



► Piggybacked site storage cabins save space

Plant and equipment need to be utilised in the most cost-effective way, for example by transporting plant and equipment from site to site so any down time is kept to a minimum. Highly trained and experienced operatives will be more productive than inexperienced ones.

Site storage facilities

The storage of plant and materials on site should be discussed at the design stage. Projects under the CDM Regulations should include arrangements for materials storage in the construction phase plan. Legislation requires sites to be kept to a good standard to prevent slips, trips and falls. Materials must be stored in clean, tidy and secure areas to prevent them becoming damaged or stolen.

A site layout plan can help identify possible storage areas. In sites with limited space, site huts and storage containers may be piggybacked (stored on top of each other). Delivery of materials will be 'as needed' due to a lack of storage space. As the project proceeds, these facilities may need to be moved to allow the construction to progress. On large sites, storage may have a permanent location.

Site distribution methods

In order to ensure that a site is operating efficiently and effectively it is vital to use a suitable store management system to issue operatives with the correct equipment and materials. Handling equipment such as cranes and forklift trucks need to be selected depending on the height and reach required for the project. The storage area will require sufficient space to allow site vehicles and delivery vehicles to access it safely. This may require a one-way system to eliminate reversing or unsafe manoeuvring.

Workforce requirements

In projects that fall under the CDM Regulations the construction work cannot start until welfare facilities have been provided. The principal contractor is responsible for the maintenance of the welfare facilities. The size and number of facilities required depends on the number of operatives working on the site. Basic welfare facilities which must be provided are toilets, washing facilities, drinking water, changing rooms and lockers for dry clothes and personal protective equipment, as well as facilities for rest.

Motivating the workforce

Labour is one of the principal resources of a project and it is vital to utilise this resource to the maximum. A content, motivated workforce is a productive workforce. Providing suitable welfare facilities such as clean toilets, a warm room to dry wet clothes and an area to eat and have warm drinks is a first step in motivating the workforce. Some other methods are shown in Table 9.4.

► **Table 9.4:** Ways to motivate staff

Method	Description
Incentives	Bonus schemes, and/or offering incentives such as company cars and vans, can reward effort by employees. Many companies operate staff discount schemes and other benefits (e.g. vouchers employees can use for services outside work, such as private health benefit schemes for families).
Awards and rewards	Can be used to improve productivity and health and safety on site. Any scheme must be communicated fully and should be simple and easy to follow. Subcontractors can also be included in the award and reward schemes. Feedback on success should be communicated through site meetings, staff briefings, toolbox talks, site inductions and even publicising in the local press where appropriate.
Job security	When people feel secure and content in their jobs, they go above and beyond their job description to help the company, improving productivity and reducing disputes. This encourages competent staff to stay with the company, promoting staff loyalty.
Training	Employees offered regular training feel valued and appreciate the opportunity to increase knowledge and gain new skills. They tend to stay loyal to the company, and it has company benefits, including health and safety.



PAUSE POINT

Explain why it is important to motivate staff on a construction site and identify the different approaches which can be used to motivate staff.

Hint

Think about what might happen if staff are not motivated.

Extend

Explain how motivating the staff can help the overall construction project.

Communication with the design and management team, the workforce and suppliers

Effective communication ensures clear understanding of the requirements on site, creates a team spirit and builds trust between the various parties involved in the project.

Part of good communication is ensuring chains of command and management structures are clear. This refers to the levels of authority within a company, and tells employees at each level who they are responsible to. These structures can vary depending on the size and nature of the company, but all employees should be clear on the structure, their responsibilities and who their manager is. If an employee does not understand the structure or ignores it, this can create problems. For example, it could lead to errors and disputes, undermine the authority of managers or create an atmosphere of uncertainty and mistrust, leading to low morale and productivity with higher rates of accidents and staff turnover.

Some of the methods a business will use for communication are shown in Table 9.5.

► **Table 9.5:** Methods of communication on site

Method of communication	Description
Team and site meetings	Regular meetings allow team members to meet and discuss the project, communicate any necessary information and achieve a balanced opinion. Meetings can be time-consuming so it is important they are focused, meaningful and successful. Formal meetings are usually held at a specific time with a set agenda, allowing those attending to prepare. Minutes will record decisions, identify actions and allocate these to team members to prevent any confusion or debate later. Topics could include progress reports, reviewing planned vs actual progress, quality issues, and planning the next period of work.
Written communication	A range of written forms of communication are used during a construction project. <ul style="list-style-type: none"> Letters – to request or transfer information accurately, usually formally. Should be signed and dated and can be used as reference or evidence in disputes.

▶ **Table 9.5:** *Continued ...*

Method of communication	Description
Written communication	<ul style="list-style-type: none"> • Report – a statement of facts and conclusions on a particular matter; often produced after an investigation by an appointed competent person. • Architect's instructions – the client's instructions must be given in writing and may include changes to the design, variations to the works, instructions to carry out tests and open up work for inspection. • Site instructions – similar to architect's instructions and given by the consultant engineer to the contractor to carry out works, purchase goods or carry out tests.
Telecommunications	On large sites, site radios can be used to communicate, such as issuing instructions to crane operators. Mobile phones are vital for quick and easy communication; however, their use on sites creates hazards and risks, for example plant drivers may be distracted by texting. It is important that the contractor has a clear policy on mobile phone use on site communicated through the site rules, site induction and toolbox talks. It may be that a safe zone for using mobile phones is established so that necessary calls can be made.
Graphical and electronic media	Electronic forms of communication, such as emails and texts, allow information to be communicated from anywhere in the world almost instantly, and is now commonplace on construction sites. Graphical communication (e.g. site drawings, building plans, etc.) are essential, as they ensure everyone can clearly see what is intended without misunderstandings. Computer-aided design (CAD) further helps communication as detailed images are produced and areas can be zoomed in on to see more detail.
Information technology	Building information modelling (BIM) creates a collaborative approach which should reduce errors and introduce more efficient ways of working. By using BIM everyone involved in a project can understand how the building is constructed by using a digital model created from information contributed from the whole team. All team members should be working to the same standards, and detailed information on the material specifications is part of the digital data contained within the model.



PAUSE POINT

List the key methods of communicating information on a construction site. List what topics should be covered during a site meeting.

Hint

Think about different forms of communication used within the construction industry.

Extend

Why is good communication essential on a construction site? What are the consequences of poor communication on site?

A2 Application of construction management techniques

When working on site, you need to understand the various site management responsibilities and the techniques used to manage a site to ensure that the project is completed efficiently, from commencement to completion, on schedule and to the client's budget.

Standard planning techniques and how these are applied to control work on site

Production and use of master programmes

Programming is a planning technique which identifies the sequence and interrelationship of the activities that need to be carried out to complete the project on time. An appropriate programme is necessary for every construction project with each activity identified and given a set time for completion. Usually the programme is presented visually, such as in a chart or graph, so that the interdependence of the activities can be clearly seen. This is an essential tool to check the project's progress, by comparing work completed against the original programme.

Most construction contracts require the contractor to produce a programme of works. This can be a non-contractual reference point or part of the contract and imply obligations to deliver the works in a certain order by specific dates. Any changes in process or time may be regarded as a breach of the contract.

Link

Drawing up delivery schedules is an important part of site management. More information about these can be found earlier in this unit in section A1.

Master programmes will include:

- ▶ dates and time periods for each activity
- ▶ the sequence or order of the activities and how they may depend on other activities
- ▶ the resources needed for each activity such as plant, labour and materials.

The master programme identifies all the main activities throughout the project and creates an overall framework of the work and identifies the time required for each of the main activities.



PAUSE POINT

Explain the purpose of a master programme and the difficulties which may arise during a project.

Hint

Think about why difficulties may arise during a construction project.

Extend

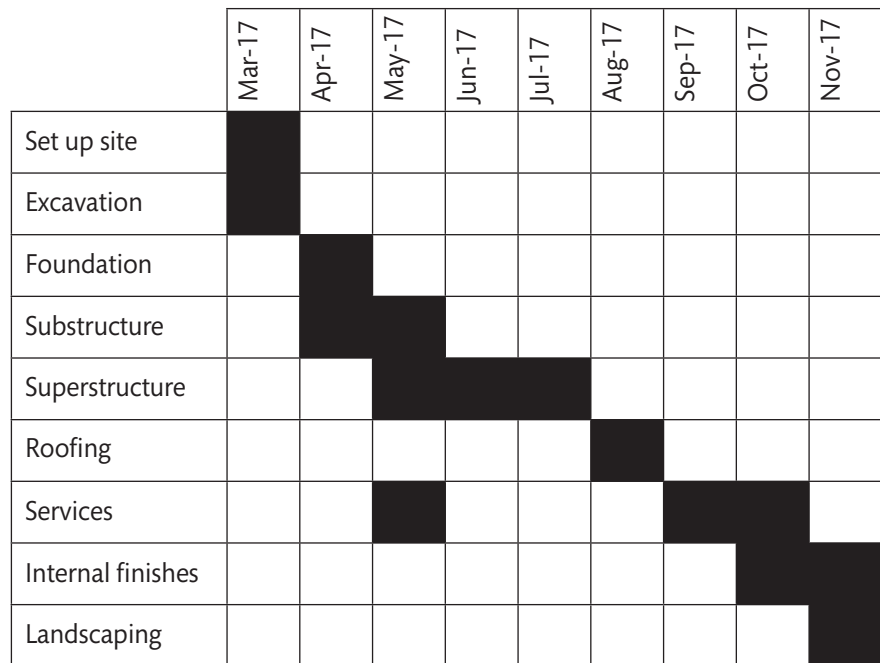
Identify the content of a master programme and explain why each aspect is required.

Three progress monitoring techniques are commonly used for construction projects, often in combination.

Gantt charts

Gantt charts are one of most common and easily understood planning methods. A Gantt chart shows a project divided into a series of activities (listed vertically) and the length of time in months or weeks (listed horizontally) required to complete each activity; see Figure 9.3.

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▶ **Figure 9.3:** Gantt chart

The length of the bar is proportional to the time required to complete the activity. Gantt charts are simple to create, easy to follow and easy to use to track progress by recording planned and actual completion dates of each activity. However, the sequence and interdependence of activities may not be completely explained. Gantt charts do not provide any information about the control of the plant, labour and materials required for each activity.

To produce a simple Gantt chart, follow this sequence:

- 1 Analyse the contract drawings and specification and establish the activities needed. A medium-sized construction site usually has around 20 activities.
- 2 Find the estimator's calculation of the length of each activity. Choose a suitable time unit to cover all the activities, such as weeks or months.
- 3 Record the logical sequence of activities so there is a working link between each.
- 4 Establish which activities are critical to the overall programme.
- 5 Plot each activity on a rough outline bar chart, beginning each at their earliest start point.
- 6 Establish the critical path through the bar chart. Some activities float within the critical activities, meaning their start or finish times can be delayed and have no overall impact on the completion date; others are critical to the overall programme and end slippage will affect the end date.
- 7 Adjust the non-critical activities to suit the plant, labour and material resources on site.

On the chart, time runs from left to right with the start of the programme being the first activity and handover the last. To monitor progress, place a string line across the programme at the current date, which will show the percentage of each bar that should be completed. This will identify which activities are ahead or behind schedule.

Critical path analysis (CPA)

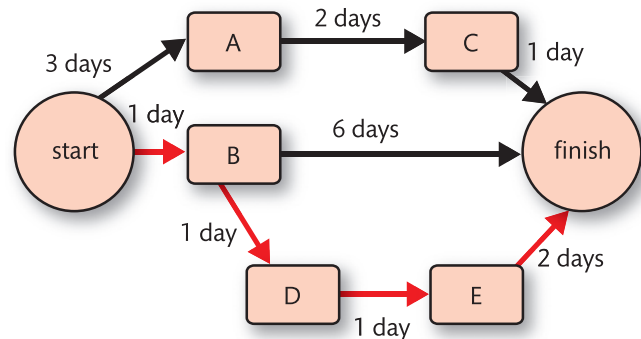
CPA is usually used for large or complex projects. It represents the plan for a project by showing the sequence and interdependence of each activity. This allows the project team to determine the minimum time the project can be completed in. Critical and non-critical activities are identified, enabling the project management to balance the resource requirements. CPA allows the team to quickly analyse the effects of delays and to determine which activities need to be prioritised. However, they can be complex and difficult to understand unless you are competent in their use and interpretation.

Each arrow on the network represents an activity. The description of the activity is above the arrow, with the duration below it. Time runs from left to right, with the first activity representing the start of the programme. See Figure 9.4 for an example of a critical path analysis. To produce a simple network:

- 1 Analyse the contract drawings and specification and establish how many activities will be needed.
- 2 Find the length of each activity as set out by the estimator. Choose a suitable time unit to cover all the activities, such as the number of days or weeks.
- 3 Record the logical sequence of activities so there is a working link between each.
- 4 Draft the network diagram using nodes and arrows.

Add the description and durations of each activity.

- 5 Calculate the left-hand side of the circle's earliest start times right through the network. Where two arrows finish at one node, take the highest value calculated starting at zero.
- 6 Work backwards from the completion node, taking the lowest value where two arrows enter a node until arriving back at the commencement, which is zero.
- 7 Identify the critical path and mark it in red - this is the path where the left-hand and the right-hand figures in the circles are the same value.

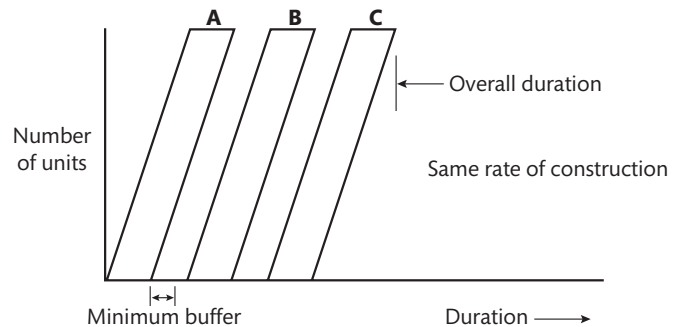


► **Figure 9.4:** Example of a critical path analysis (CPA)

Line of balance

Line of balance (LOB) is similar to a Gantt chart as the bars represent activities but the time is plotted on the horizontal axis with the number of units or sections requiring similar activities plotted on the left-hand vertical axis. LOB is a visual diagram representing the rate of working of repetitive activities; see Figure 9.5.

LOB is suitable for repetitive work such as constructing a large housing project or building floors in a multi-storey project.



► **Figure 9.5:** Line of balance (LOB)

Daily activity sheets

Daily activity sheets are a record of the work which has been completed each day to track the progress made.

Production of site layout plan

Site layout plans must be prepared by the contractor before any work is carried out. On large or complex sites,

Discussion

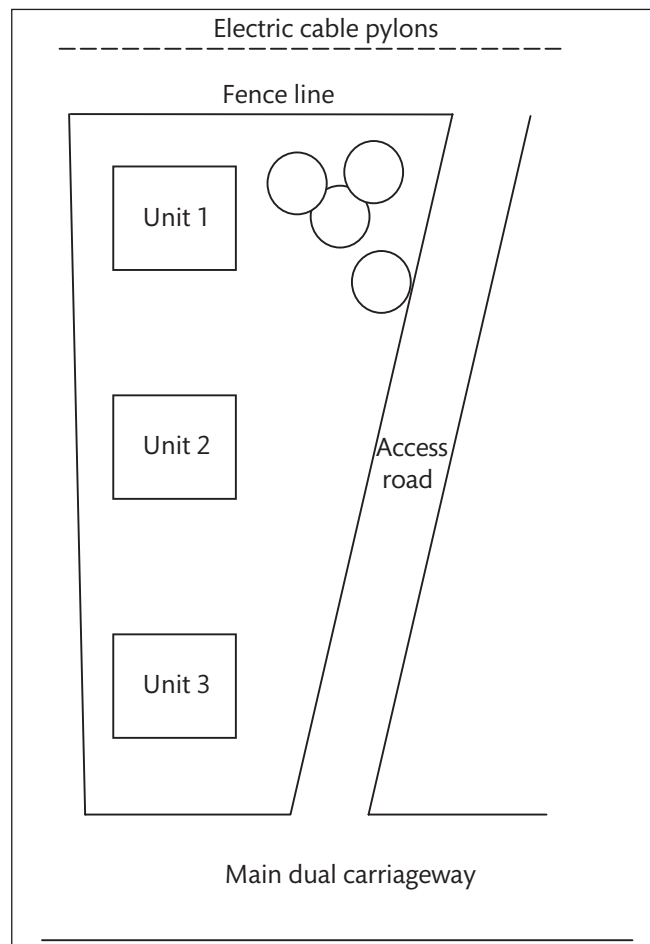
Discuss with a partner or group which progress monitoring technique you would prefer to use. Give a reason to support your choice.

Key term

Footprint – the shape of the building on the ground when viewed in plan from above.

a site layout plan is vital to organise the movement of plant, labour and materials effectively. The plan will be governed by the size of the site and the **footprint** of the building to be built. Though the principles for organising a site will be the same, each site will be unique. Detailed planning of the site layout can reduce the distance materials need to be moved, reduce traffic congestion and improve the health and safety on site, improving staff morale and productivity.

Figure 9.6 shows a typical site layout plan in which the contractor would construct the building. The site layout plan is drawn to scale and, once complete, passed to the site supervisor to add all the site accommodation, box containers, traffic routes, etc.



► **Figure 9.6:** Site layout plan



PAUSE POINT

How would the location of the site affect the access and exit points?

Hint

Think about the issues that might need to be considered for a site based in the city centre compared with one in the countryside.

Extend

What other factors would be determined by the location of the site?

Link

Information on completing risk assessments can be found in Unit 5: Health and Safety in Construction, section B2.

Method statements and risk assessments

Risk assessments are required under the Management of Health and Safety at Work Regulations to manage risks at work. A method statement outlines the sequence of activities, the planned resource requirement and the planned duration for the main activities. Method statements help manage the work and ensure that any precautions have been communicated to those involved. There are two types of method statement:

- ▶ A detailed description of how a task is carried out, listing the resources required, including labour, plant and materials. This helps to identify the hazards and the control measures needed.
- ▶ The estimator lists the labour, plant and machinery needed. This is used by the contracts manager to establish the construction plant required and how much it will cost.

Risk assessments and method statements are often described as RAMS. RAMS may be required by the principal contractor from subcontractors to establish that health and safety has been considered and the requirements of the CDM Regulations have been met. If they are not produced, or are not suitable, the subcontractor will not be allowed to work on the site.

The application of quality assurance and quality control requirements

QA is a quality management system designed to prevent defects, errors and accidents and ensure that agreed standards are achieved. Quality control is a method to ensure the consistent quality of the materials or work by aiming to identify defects in the materials or work produced.

There are several key processes used in QA, as shown in Table 9.6.

▶ **Table 9.6:** QA processes

Process	Description
Document control	A huge number of documents are used during a construction project. A system must be in place to control them. The project team may have their own quality management system or may use ISO 9001 certification to control documentation. Document management systems (DMS) automatically name, number, track changes, create versions, archive and share documents. Everyone involved must be committed to document control to prevent problems and disputes. The government requires building information modelling (BIM) to be used in public sector projects.
Drawing registers	Managed by the principal contractor to keep track of the changes made to the construction drawings as the design is amended and altered, a drawings register should include: <ul style="list-style-type: none"> • date and time of receipt • drawing number and revision number • drawing title • accompanying document reference, for example site instruction (SI), drawing amendment notification (DAN), variation order (VO), etc. BIM reduces the chances of out-of-date drawings being used to construct the project.
Specification use	Contract drawings show what the finished product should look like. Specifications provide essential information about the materials, finish and workmanship required. They do not lay down how the work should take place, but should confirm the requirements for the safe and successful installation of a particular component. BIM and data modelling techniques offer greater control and detail when producing specifications. Specifications are created early so that they can develop and change alongside the project. This means they should be more consistent, allow less room for errors and save time and money.
Site testing	The clerk of works reports on quality and project progress to the client and instructs on-site tests to be carried out. This monitors the quality of the materials and workmanship throughout construction. Samples are taken of various materials, sometimes by request specifically from the architect. For example, concrete is tested using a slump test to ensure workability when it arrives on site. Other site testing may involve load testing or crack monitoring.
Off-site testing	Some samples need to be taken to a materials testing laboratory, which should have United Kingdom Accreditation Service (UKAS) accreditation for testing and calibration of materials. Tests are carried out on a range of materials such as concrete, masonry and steel. For example, concrete strength is assessed at regular intervals by making concrete cubes and testing them to destruction at specific time intervals within a controlled environment. Tests can also be carried out on manufactured products such as windows and doors to ensure they meet specifications.
Dimensional quality control	All buildings need to be set out with absolute accuracy using modern, UKAS-accredited, calibrated equipment, to avoid errors and disruption to the project. Quality checks should be in place to identify any errors early. Surveyors carrying out checks should have the most up-to-date site plan. Building co-ordinates should be calculated correctly and uploaded onto survey equipment. Control or reference points should be located in places that will not be disturbed during construction.

Research

Research some examples of risk assessments and method statements which are used on construction projects. What do they have in common? To what extent do you think they are successful in managing health and safety risks?

Key term

Slump test – a test of concrete's workability to determine whether it is of the right quality and can be poured with the correct results.



PAUSE POINT

What is the difference between quality assurance and quality control?

Hint

Refer to the explanations on the page.

Extend

What methods are available for monitoring quality on a construction project?

Link

More information can be found about Building Regulations and the NHBC in Unit 8: Building Regulations in section A.

Discussion

As a group discuss the advantages of Building Control inspections. Are there any disadvantages with Building Control inspections?

Compliance with statutory liaison

A statutory liaison is a communication required by law with a group or body such as the local planning authority, Building Control, Environmental Agency, Historic England, etc.

Building Regulations Notices and inspection

The Building Regulations set out minimum standards for producing houses and commercial buildings that are safe and secure for the occupants. They ensure the safety and the quality control of buildings.

Most building work in the UK requires approval from the local authority Building Control department, gained by Full Plans approval or Building Notice approval. With a full application, Building Control inspect the drawings for any issues before building begins. With Building Notice approval, work can start immediately but, if any problems are found, Building Control can demand work is taken down and fixed. Building Notice is best suited to small domestic building projects.

The Building Regulations require inspections by Building Control officers to be carried out throughout construction to ensure all work complies with the regulations. The builder or project manager must notify Building Control that the project has started. An initial inspection will be carried out to stipulate what further inspections will be required. On completion of the work, if it meets the approved standard, a completion certificate is issued as evidence that the work meets the standards. This is required when selling the property.

National House Building Council (NHBC) inspections and standards

The NHBC is an independent body which aims to raise standards and improve quality in UK housebuilding. It is approved to carry out inspections for Building Regulations and provide other services such as energy rating of houses, and health and safety training. Most new houses built in the UK have an NHBC ten-year warranty, which is granted after a final inspection by an independent NHBC inspector, who will also conduct inspections throughout the construction process. Mortgage lenders often require an NHBC warranty to be issued before releasing any funds.

NHBC technical standards and inspections are in addition to Building Control regulations and inspections, not in place of them, and guarantee a high standard of building.

Application of on-site sampling and material testing techniques

There are many reasons for sampling and testing materials on site, mainly to ensure materials are fit for purpose, meet the quality and performance requirements of British and European standards and comply with the Building Regulations. It may also be necessary to sample and test material if there are problems or failure on site. These tests can also help resolve disputes.

Testing the quality and consistency of raw materials is vital to ensure the finished product is acceptable, for example by ensuring the quality of the concrete poured on site for walls, floors, columns and beams. Errors and defects at this stage create major problems later in the construction process. Finished products also need to be tested to ensure quality and performance, such as precast concrete products used for floor slabs or lintels.

Supervision and inspection of the quality of outcomes produced by the workforce

The quality and quantity of work produced on site must be regularly monitored and inspected to ensure the project is completed to the required standard, time and budget. If work activities fall behind schedule due to low productivity or poor workmanship, redistribution of labour resources from one activity to another can help resolve this. Progress is monitored by evaluating the level of production achieved on site against contract programme activity. Quality of work can be tested and inspected by competent staff such as the clerk of works. Output from the labourers can then be raised to meet any shortfall if an item is behind programme.

Management of direct workforce

When managing the workforce, several key issues must be addressed to ensure that the team is working safely and effectively. Some of these are shown in Table 9.7.

► **Table 9.7:** Factors when managing the direct workforce

Factor	Description
Recruitment and competence requirements	The company will follow a recruitment process, which may involve an application form, interview, checking qualifications and references and a possible demonstration of skills before offering a job. This ensures the candidate is both suitable and competent to do the work.
Training	Under HASAWA 1974, it is the employer's responsibility to provide information, instruction and training to ensure employees have the skills and knowledge for their role. Operatives must also have the minimum health and safety training required by the CSCS card prior to entering a construction site. CSCS cards provide evidence that operatives are competent and have the qualifications and training for their trade. The CSCS scheme is recognised throughout the construction industry and has a register of individuals working in construction and their training and qualifications. For more about CSCS cards, see Unit 5: Health and Safety in Construction, section A6.
Monitoring equal opportunities	Employers must be aware of the Equality Act 2010 and its implications. It is in place to prevent discrimination on grounds of race, religion, age, sex, disability, pregnancy or maternity, or sexual orientation. It ensures recruitment is fair and that the best candidate for the job is employed. Regular staff training ensures all staff are aware of the company's equal opportunity policy. Monitoring all applications for equal opportunity purposes is good practice and enables companies to identify potential areas where discrimination may be taking place.
Leadership skills	Strong leaders motivate and inspire the team to work productively. Good managers will be able to employ a range of skills to motivate the employees to ensure the project is completed to time, quality and budget. These may include prompt, clear communication, setting clear goals, demonstrating a positive attitude, praising workers in public and disciplining them in private, leading by example and allowing team members some responsibility and independence.

Management of subcontractors

Techniques for managing subcontractors effectively include:

- Communication methods – good communication is crucial as a large proportion of site work is subcontracted. Regular contact ensures co-ordination between different subcontractors. Weekly site meetings should be in place with all key subcontractors attending. Health and safety compliance, site rules, access and egress issues, use

of crantage, waste disposal, and storage are just some of the items that need to be co-ordinated. Other forms of communication include, for example:

- signage – to clearly alert workers of hazards
- team meetings – to ensure a good understanding across the team
- one-to-ones – where specific points need to be raised with a particular member of the team
- site/project handbook – clearly outlining the discipline expectations, and health and safety considerations for the site.

As for the leadership skills discussed in Table 9.7, good communication requires careful use of language to instruct, motivate, persuade and discipline the workers.

- ▶ **Checking insurance and legal requirements** – The project team needs to check subcontractors are competent, with the right combination of skills, experience and knowledge to carry out work safely and correctly. The principal contractor must check the subcontractor's liability insurance to confirm they are insured to carry out any work. The principal contractor must also check the RAMS of the subcontractor to ensure they are using the correct equipment.
- ▶ **Responsibility for compliance** – The project team has responsibility to ensure the subcontractors are complying with all site rules and regulations. Clear communication and regular checks on progress will encourage this.
- ▶ **Retention of payment** – Retention is holding back a percentage of the overall amount for a specific job or activity, often between 5 and 10 per cent. This means the subcontractor will not be paid the full amount until the work is completed as required. This fee may not be released until after an agreed 'defects liability period' such as six or twelve months. Often the fee will only be released when certification of completion has been issued. If this practice is not managed correctly, it can lead to disputes over subcontractors demanding their retention fee and clients demanding aspects of the work be completed fully.
- ▶ **Remedial work required** – Defects due to inappropriate specification, detailing and design can occur in any element of the building as shown in Table 9.8. Faults and defects must be repaired at no additional cost before handover. Many defects are identified in the initial stages of the building handover and the builder will be liable to make repairs. This is referred to as the 'snagging list'.

▶ **Table 9.8:** Common defects found during construction

Section of building	Defects which may require maintenance and repair
Foundations	Settlement of building, waterproofing for leaking basements
Walls	Dampness penetration, condensation, thermal bridging
Floors	Poor noise and heat insulation
Materials	Timber (cut wrongly or split), steel (scratched or corroding)
Services – plumbing, electrics	Leaks, system not working, faulty fire alarms or wiring

Assessment practice 9.1

A.P1

A.P2

A.M1

A.M2

A.D1

A local property developer wants to research her options in building a number of medium and large projects. She will need to engage a project management team to organise and plan the projects. The developer has mainly dealt with small projects and has asked your advice on the roles and responsibilities required for a successful project management team and the techniques required to manage key resources. She asks you to research the most suitable methods of monitoring quality and progress.

To achieve this, research and produce a brief booklet on the roles and responsibilities of each of the members of a project management team and the management of the principal resources including:

- labour and material requirements
- plant and equipment requirements
- motivating the workforce
- communication methods within the team.

The second part of the booklet should explain the techniques applied by a site manager to manage the project such as:

- programme techniques
- quality assurance and quality control techniques
- compliance with statutory requirements
- management of workforce – direct labour and subcontractors.

Plan

- How will I research the roles and responsibilities of members of the project team?
- How will I prepare brief descriptions of techniques applied by a site manager to manage the project?

Do

- Am I including as much detail as possible?
- When will I be ready to present the booklet to my peers for additional suggestions?

Review

- I can explain how I would approach the difficult elements differently.
- Once I have reflected on my own work and any feedback, I will make any necessary changes in my booklet.

B Understand purchasing and cost management techniques

B1 Application of purchasing methods

The project management team must create a system to deliver the required quantity of materials to site on time, budget and to quality. Without a robust system, the project may become delayed or incur additional costs.

List of selected suppliers

The selection of reliable suppliers for the project is crucial. By introducing a selection process, and judging suppliers against set criteria, it is possible to manage the risks associated with the supply and delivery of plant and materials. Factors to consider include looking carefully at the supplier and their:

- ▶ area of operations (where do they operate?)
- ▶ previous performance on past projects they have worked on
- ▶ operational capacity to supply what the project needs
- ▶ reputation among other clients and staff
- ▶ stock levels and the speed at which they can replace used stock
- ▶ ability to meet any changes in demand on the project.



PAUSE POINT

What factors may influence your choice of suppliers for a project?

Hint

List as many factors as would influence your choice of supplier.

Extend

Looking at your list of factors, discuss which would be the most important and explain why.

Link

More information about scheduling materials or extracts from bills of quantities and the use of correct and appropriate specifications can be found in Unit 13: Measurement Techniques in Construction (section C2) and Unit 3: Tendering and Estimating (section A1).

Materials and subcontract enquiries

It is good practice to get a written quotation from at least three different subcontractors. A quote is an agreement to carry out specific work for a fixed price. It is important to be very specific about what work is required, the quality of materials to be used and the time to complete the work. The client compares the quotes to determine which offers the best value (not just the lowest price). Before accepting a quotation, the client should research the subcontractor to review their previous performance and reputation. Once a client accepts a quotation this becomes a binding agreement between the client and subcontractor.

The receipt of quotations should be acknowledged, and the quotation checked to ensure it is correct and has not omitted anything. Both the client and contractor or subcontractor should be clear on the exact work needed in terms of quality of materials and time to complete work.

Gap analysis

Gap analysis is a method of comparing actual performance against potential performance. It can identify gaps in areas of responsibility or overlaps in work processes. These gaps occur over time due to change in work processes and a lack of attention to monitoring and controlling.

Negotiating skills

As well as price, there are many criteria which should be considered when engaging a subcontractor, including quality of workmanship, reliability and their ability to work in a team. The subcontractor should have good communication skills and be able to work with the project team. There are often many changes to design and delays. It is therefore important that the subcontractor can be flexible and negotiate when resolving design changes and delays rather than causing further delays with disputes.

Planning links

Purchasing materials

Materials are one of the principal resources needed for a construction project. As projects become more complex and more expensive, it is more important to manage the purchase and delivery of materials to match the construction programme and control the potential for delays and increased costs.

Material **procurement** planning (MPP) is the process of managing purchasing materials in the right quantity, from the right supplier at the right time. Effective management of materials can result in significant savings.

Key term

Procurement – the process or act of buying or acquiring goods or materials.

Lead times

Lead time is the time taken between placing an order and the item being delivered to site. It can involve the time taken to achieve statutory approval, plant hire and production of drawings and designs.

To prevent delay it is critical to identify early any items with long lead times and their impact on the project if they were to arrive late highlighted. There may be long lead times for items such as bespoke cladding or window systems, glulam beams, steel or concrete frames, items sourced overseas and specialist plant such as cranes and tunnelling equipment.

Just-in-time deliveries

When a just-in-time delivery system is being used, a detailed tracking process of the progress of the project must be kept to ensure that materials and plant are delivered when they are needed. Although there may be additional costs in engaging suppliers to store materials longer and guarantee delivery, there are distinct advantages such as reduced waste, greater productivity and higher quality of product.

This method prevents the need for large storage areas on site. However, any supply problems can have a major impact on the cost and completion time for the project.

Discussion

Divide into two groups. One group must discuss the impact on a project of items with long lead times and how best these can be managed, while the other group discusses the advantages and disadvantages of just-in-time deliveries. As a class discuss the importance of planning deliveries and the impact poor planning may have on the construction programme.

Ethical purchasing and supply

An ethical purchasing policy aims to promote suitable working conditions and environmentally friendly standards along the supply chain, and ensure no one is exploited. Increased public awareness of poor working conditions abroad has increased pressure on companies to take responsibility for the working conditions of the workforce in their supply chain around the world. Ethical policies focus on safe working conditions, the encouragement of good health, reasonable working hours, pay meeting local legal standards and eradicating slave and child labour.

Local sourcing and minimising transportation

Local sourcing of sustainable materials ensures the materials used match other buildings in the area and blend in with the surroundings, helping to support the local community. This improves the reliability of delivery times and reduces costs.

Local sourcing also reduces CO₂ emissions because materials are transported shorter distances. Accurate planning of deliveries can reduce the number of journeys required, reducing transport costs and resulting in lower emissions. In addition, planning can reduce traffic in the area, minimising noise and emissions.

Another benefit of local sourcing is that it promotes local jobs in the supply chain.

Use of sustainable materials

The environmental costs of producing materials such as concrete and steel for the construction industry can be measured by calculating the embedded energy in the material.

As awareness for the need to protect the planet increases, so has the requirement to incorporate sustainable materials into construction project design. A sustainable material is naturally produced and can be replaced at the same speed it is used, for example timber, clay and cork. Their advantages are that they:

- ▶ conserve energy and save money (for example, low flow toilets and natural insulation material)
- ▶ minimise the carbon footprint (for example, using reclaimed or recycled materials)
- ▶ reduce the energy use and financial costs of transportation
- ▶ make a healthy, comfortable home (for example, better air quality and temperature control)
- ▶ can create an aesthetically pleasing finish to a building
- ▶ reduce the damage caused to the environment.

Many materials used in construction, such as concrete, asphalt, metals, masonry, plastic and glass, can be recycled. Recycling reduces the amount of material going to landfill and the depletion of natural resources.

Fair trade agreements

Fair trade agreements mean the producer of the product receives a fair price for their product, based on the global market price. This may make it more expensive than from other producers but it guarantees minimum standards of pay and working conditions for all the workers. It ensures workers in other countries are not exploited and helps provide them with opportunities to improve their standard of living.

Abuse of power

The Competition Act 1998 deals specifically with abuse of dominant position in business dealings. This law was created to prevent powerful companies pressuring smaller companies into agreeing unfair deals or contracts, such as making the purchase of one product conditional on the sale of another product, demanding

Theory into practice

You have been tasked with ordering a range of materials for a project:

- 10,000 – 7.3N solid dense block 100 mm
- 10,000 – red multi-facing bricks 65 mm
- 10 – concrete lintels 1500 mm

Calculate quotes for all the materials using prices obtained from three different online building suppliers. Was there any discount for larger quantities? Are all the materials labelled the same? List any difficulties you encountered when calculating the costs.

Link

More information on sustainability can be found in Unit 2: Construction Design (section C4).

Research

- Make a list of materials commonly used in construction projects. Research how each material may be reused or recycled.
- Find a definition of embedded energy and research the embedded energy for each material you listed.

that suppliers only supply to them, refusing to deal with other companies, charging unreasonably high prices and selling at artificially low prices with which smaller companies cannot compete.

Avoidance of corruption

Corruption is the dishonest or fraudulent behaviour of people or companies to gain advantages and often involves bribery. The construction industry has a poor record on corruption and is one of the most susceptible sectors. Corruption in the construction industry can take the form of bribery to obtain planning permission, overestimating or underestimating land values and collusion to monopolise the market.

In 2009 the Office of Fair Trading (OFT) fined 103 construction firms in the UK a total of £129.5 million as punishment for breaching competition law. The companies were found guilty of participating in anti-competitive bid-rigging in the form of **cover pricing**. As a result, a Chartered Institute of Building (CIOB) report made a number of recommendations, including:

- ▶ supporting the development and implementation of industry-wide anti-corruption mechanisms
- ▶ setting up a co-ordinated approach from the government to tackle corruption
- ▶ equipping industry with relevant anti-corruption training
- ▶ increasing awareness of corruption and measures to report it.

Social responsibility

Social responsibility is not only about delivering success for a company but also delivering benefits for the local community. Social responsibility can be beneficial for the company in that it builds trust and improves the reputation of a company. By involving the local community through employing local people on the project, investing in local projects and improving local facilities the construction project can avoid disputes with and disruption to the local community, saving money over the length of the project. The Considerate Constructors Scheme (CCS) is a national scheme set up in 1997 to improve the image of the construction industry in the UK. The CCS checklist has five major sections:

- ▶ Care about appearance – site, facilities and personnel.
- ▶ Respect the community – anyone affected by construction work.
- ▶ Protect the environment – protect it, enhance it.
- ▶ Ensure everyone's safety – minimise risks.
- ▶ Value their workforce – workforce health and wellbeing.

Key term

Cover pricing – an anti-competitive practice in which companies submit an artificially high bid for work with the intention of not winning the bid. This allows other companies to submit higher than necessary prices for work, with the knowledge that they will win as their competitors have submitted very high quotes. They can then divide several tenders among themselves at higher prices.



PAUSE POINT

What ethical factors should be considered before purchasing materials from a supplier?

Hint

Close this book and, in two minutes, list as many ethical factors that you can think of that should be considered before purchasing materials.

Extend

Looking at your list of factors, discuss which would be the most important and why.

Purchase orders

The process of ordering materials should follow a basic system such as:

- ▶ Request – create a requisition order for the required materials or items.
- ▶ Approve – specified staff members agree to go ahead with the purchase as part of an approval process.
- ▶ Purchase – create and send purchase orders to suppliers as an indication of willingness to purchase.
- ▶ Receive – delivery of materials or items to the specified destination (see section A1 above for more information on timing and delivery).
- ▶ Pay – payment made to supplier.

A purchase order is created by a buyer and details quantities, prices, payment terms and delivery dates. The information on a purchase order must be correct otherwise it can lead to disagreements, errors, delays and additional costs. The specification of the materials, and the number of items, should be clearly recorded on the purchase order and checked by a senior member of the project team before ordering, as it becomes legally binding once accepted by a supplier. The benefits of purchase orders are that they:

- ▶ can save time and money and avoid cash flow problems by allowing better control over budgets
- ▶ reduce fraud within the company by providing an audit trail and producing accurate records of expenditure
- ▶ provide easy access to records to identify trends and plan budgets
- ▶ reassure suppliers that the company is willing and able to pay.

Terms and conditions are general and specific arrangements which are part of the contract formed between the buyer and supplier as part of the purchase order. Any changes to these will not apply unless they have been agreed in writing between both parties.

The buyer can negotiate discounts for repeat and bulk orders. Materials or items that are ordered on a regular basis may be added to a supplier list with a reduced or discounted price.

Benefits and drawbacks of serial and term contracts

Annual supply contract

An annual supply contract is an agreement between a buyer and a supplier to provide materials or services over a year. They:

- ▶ protect the construction company from variations in prices, and improve financial stability in terms of prices, quality of materials and service provided
- ▶ provide both the main buyer (main contractor) and the supplier with a degree of certainty about work due and allow both to plan ahead and make arrangements
- ▶ reduce administration costs for repeat bidding, quotations and purchase orders
- ▶ enable more accurate control of spending and improvements in the cash flow to be managed
- ▶ facilitate a reliable supply of materials, which can be scheduled to meet the tight demands of the construction programme.

A drawback of an annual supply contract is that it may reduce the competitiveness of the process and lead to increased costs for the buyer and complacency from the supplier.

Multiple project contracts

Multiple contracts subdivide a large project into a series of smaller construction phases, for which contracts are awarded sequentially. For example, a contract would be awarded for the groundworks and foundations. Afterwards a further contract would be awarded for the superstructure. These contracts require more careful co-ordination and close monitoring, as several contractors may be involved in the project, and no single contractor is held responsible for the job as a whole.

Serial contracts

Serial contracts can be used for repetitive works such as housing or maintenance work. An initial contract can be agreed for one item and then be reused for a series of similar projects. For example, a developer may agree a contract with a subcontractor to build one or two houses within a housing scheme. If the houses are sold the developer can roll the contract on to build more houses but if the houses do not sell the developer is not tied into a long-term contract. Serial contracts can reduce tender costs and may encourage suppliers to keep costs low to secure regular work.

Research

Contact a local construction company and request examples of purchase orders. Summarise the information contained on the purchase order.



PAUSE POINT

What are the different types of contract for purchasing materials?

Hint

For each type of contract for purchasing materials list the advantages and drawbacks.

Extend

For each type give an example of a construction project for which it might be used.

B2 Cost management techniques

Link

More information about cost management techniques, including cash flow management and managing costs, can be found in Unit 3: Tendering and Estimating (section A5).

Analysis of interim claims

Preliminary items

Preliminaries are usually the first section of a bill of quantities and establish the general responsibilities of the contractor. The preliminary items tend to be time-related costs that cannot be easily priced. Typical preliminary items would be:

- ▶ a general outline of the site and work to be completed
- ▶ risk assessments and method statements
- ▶ requirements of statutory approvals
- ▶ the employer's requirements in relation to quality control and health and safety
- ▶ services and facilities, for example temporary water supply
- ▶ identification of work or materials which have been arranged by the client with specific suppliers or subcontractors
- ▶ requirements for insurance and product warranties
- ▶ details of the site waste management plan
- ▶ a list of the conditions of the contract.

Pricing the preliminaries in a project is one of the most difficult sections of the bill of quantities. In order to price accurately, the quantity surveyor must include all the general costs linked with managing the project.

Measured work by trade or element breakdown

This section of the bill of quantities shows quantities of work or items measured following the standard method of measurement, i.e. the new rules of measurement (NRM; see Unit 3, section B3, and Unit 13, section A2). Each item is listed individually and contains a description, unit of measurement and quantity. There is also a column for the contractor to provide a price or unit rate. Measured work by trade or element breakdown allows work that is initially difficult to quantify to be measured as the work progresses, e.g. excavations where the amount of material to be removed is uncertain.

Nominated subcontract values

A nominated subcontractor is one selected by the client to be used by the main contractor as part of the contract. A nominated subcontractor's work may be valued separately by the quantity surveyor and will be shown as a separate amount on the interim certificate. The subcontractor will be informed of this payment. If the nominated subcontractor is not paid on time by the main contractor, the client may pay them directly.

Materials on site

Generally, for construction projects, the contractor sources, orders and pays for materials and the client pays the contractor once the materials arrive. The contractor may claim payment for the materials delivered even if they have not been used in the building. In some cases, the client may pay the contractor in advance for materials to enable the contractor to purchase and deliver them on time. This improves the contractor's cash flow and reduces the chance of the contractor becoming insolvent, as material cost can be significant.

Discussion

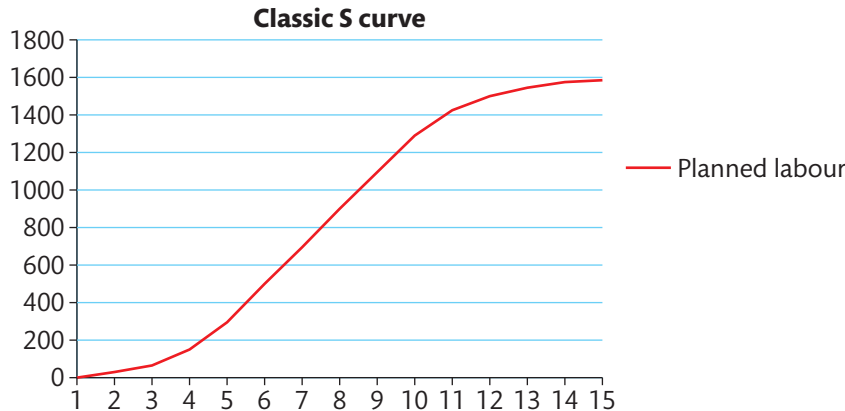
As a class, discuss how the project management team can use the following to plan and manage the costs of the project: preliminary items, measured work by trade, nominated subcontract values, materials on site.

Cost value comparisons

There are several cost value comparisons that can be used to help a business make a decision. These are explained in Table 9.9.

Table 9.9: Types of cost value comparison

Comparison system	Description
Costs from management information systems (MIS)	MIS are used to gather information to generate reports and assist managers with decision-making. A contractor would use an MIS to monitor expenditure and income of the company to make it more effective and efficient. The system's accuracy will depend on the accuracy of the data collection and input. Cost estimating is incorporated into BIM.
Monthly valuations reconciled with project costs	A comparison of the monthly valuations carried out and paid through interim certificates against the value of work completed. They are usually carried out by the contractor to give an indication of the job's profitability, allowing the contractor to determine if initial cost estimates were accurate and whether these can be adjusted for future work.
Profit and loss projections	An estimate of the amount of money the contractor will be paid for work or services over a specific time or project against an estimate of the amount of money the contractor will have to spend on variable costs (e.g. materials) and fixed costs (e.g. employee wages, insurance, etc.). Using these, a contractor can determine how much work they need, and how much to charge, to make a profit (i.e. when the income is greater than the expenditure). If expenditure exceeds income, the contractor is making a loss and will need to make changes to the business.
Cash flow forecasting	It is important to keep track of when cash is expected to come into, and out of, the company. A cash flow profile is often called an S curve as initial payments are low but increase as the amount of work and materials used increase (see Figure 9.7). <ul style="list-style-type: none"> For a client, cash flow will always be negative as they are continually paying out for work as it is completed. The forecast indicates when they need more finance, in this case as the project moves closer to completion. For the contractor, cash flow can be positive (money received) and negative (money paid). It identifies possible deficits (more cash going out) or surpluses (more cash coming in), allowing better control of the project's budget.



► **Figure 9.7:** An example of a cash flow S curve



PAUSE POINT

What cost value comparison methods provide information on the value of work completed and the expected financial outcomes of the project?

Hint

Write down the different cost value comparison techniques available to the project management team.

Extend

Explain the difference between profit and loss projections and cash flow forecasts.

Managing costs

Managing costs during a project is essential to provide financial security for the client. Factors which can affect the budget include design changes, increased material and labour costs, disputes and weather. Despite these it is essential to be alert to the build-up of costs throughout the project. Accurate cost estimates of the work must be carried out to monitor actual costs against projected costs.

Discussion

Divide into four groups. Each group should select a type of cost from the list opposite, agree a definition and create a list of examples of that cost which would be encountered on a construction project. Come together and create a full list of examples and identify which type of cost each would be.

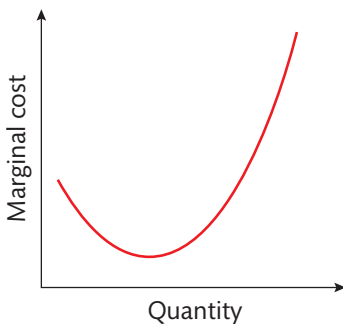
The following are financial terms used in relation to managing a project:

- ▶ **Estimated costs** – an approximation of the costs relating to a project using the unit method (e.g. price per bed for a hospital), superficial method (based on floor area) or elemental method (see element costing).
- ▶ **Variable costs** – these depend on the volume of work. Examples include the price of materials, hiring or purchasing plant and machinery, subcontractors employed, labour rates and fuel costs.
- ▶ **Fixed costs** – necessary costs that are independent of the volume of work, e.g. office rent, business insurance and bank loan payments.
- ▶ **Target costs** – these share the financial risk between client and contractor and are agreed early in the project. If the project is completed under budget, the savings are shared by contractor and client, just as additional costs from going over budget are shared.
- ▶ **Actual costs** – these reflect actual costs incurred on the project.

There are several techniques available to break down, itemise and control project costs, as described in Table 9.10.

▶ **Table 9.10:** Techniques for breaking down, itemising and controlling project costs

Techniques for controlling project cost	Description
Unit costing	Units of work detailed in a bill of quantities are costed individually (unit rates). Each unit rate is broken into sections such as labour, materials and plant. The quantity surveyor must determine the correct units for each item, such as weight, length, area or volume. The rates for each section are calculated and priced, based on historical data from similar projects and information from price booklets. This can be time-consuming and costly for large projects as a lot of detail and information is needed.
Element costing	The project is divided into elements. The Royal Institution of Chartered Surveyors (RICS) Building Cost Information Service (BCIS) provides current cost and price information based on a list of these elements. The list used will depend on the project. The cost for each element is calculated, allowing accurate estimates of the project cost at an early stage by following a standard system. It also allows regular comparisons against costs and work completed.
Marginal costing	Separates fixed and variable costs. Cost data is studied to understand the effect of profit changes due to volume of output. Initially costs are high but reduce as work volume increases, due to economy of scale. The larger the work volume, the greater the discount on materials and maximisation of the use of plant. This can reach a point where costs increase again as more labour and plant is required (see Figure 9.8). If the price charged is more than the marginal cost, the company makes a profit but, if the price is less than the marginal cost, the company makes a loss.
Variance analysis	Identifies the differences between planned costs and actual costs. Variance is the difference or change between a planned and actual amount. For example, a company produces 10,000 precast concrete slabs. The planned expenditure was £30,000 but actual expenditure was £35,000 – a variance of £5,000. Regular variance analysis throughout a project allows the project price to be adjusted to ensure it remains on budget.



▶ **Figure 9.8:** An example of a marginal cost U curve

Link

More information about making savings on plant, materials, site set-up and site management structure can be found earlier in this unit, in section A1.

Cost savings: Labour

There are other ways to reduce labour costs than redundancies. Redundancies may come with financial costs and thus have little initial cost saving. These other methods can include:

- ▶ freeze on recruitment and pay rises
- ▶ reduce or eliminate bonus payments, overtime or temporary contracts
- ▶ reduced hours contracts
- ▶ improve management of absenteeism
- ▶ improve efficiency of workforce such as modernise equipment or software to speed up processes.

Cost savings: Methodologies

With increasing global competition, it is crucial for construction companies to maintain a cost saving methodology or strategy. Such a strategy may follow a system such as:

- ▶ creating an effective database of costs for the project
- ▶ identifying the major factors which influence the costs
- ▶ identifying areas for saving, such as improved design, change of materials, changes in processes, alternative suppliers, energy efficiency
- ▶ continually implementing the changes.

Cost savings: Programme acceleration or deceleration

It may be necessary to accelerate the work on a project, usually because the project has been delayed at critical points and the financial implications of falling behind are significant. Contractors and subcontractors may receive extra payments for accelerating work. Alternatively, there may be large bonuses for finishing the project early.

Programme deceleration (slowing work down) may be necessary to comply with the critical points within the programme and ensure it remains on budget. Resources may be directed to other projects until they are required.

Theory into practice

A client has bought a brownfield site on the edge of a seaside town. The town is close to a major city and has good transport links to the city. The client wants to build 200 houses on the site but is concerned about the poor reputation the construction industry has in completing projects on time and budget. He asks you to provide advice on how to identify cost savings in plant, labour, materials, site set-up and site management structure. Prepare a short report outlining the options for reducing costs in these areas.

Preparing and examining elemental and project comparison costs

The analysis of the data from preparing elemental costings and comparing them to the actual costs of the project enable the project team to monitor the project cost. This information can also be used for pricing future projects.

The elemental method is used to estimate the cost of the project and to determine the budget. Comparing this estimate against the actual cost of the project allows the management team to monitor the budget and establish the estimate's accuracy. The information gathered from one project can be taken onto future projects and help the next project to be estimated more accurately.



PAUSE POINT

What techniques can be used to obtain an accurate cost of a project?

Hint

Think about how a project can be divided into units and elements of work.

Extend

Why is it important to analyse the variance between planned costs and actual costs?

Assessment practice 9.2

B.P3

B.P4

B.M3

B.M4

B.D2

The local property developer was impressed by your previous research and booklet. She is now working with the project management team but would like you to prepare a short presentation to explain the methods used by construction companies to facilitate the supply of appropriate materials to the site. You should focus on:

- application of purchasing methods
- list of selected suppliers
- materials and subcontract enquiries
- planning links
- ethical purchasing
- purchase orders
- benefits and drawbacks of serial and term contracts.

The second part of the presentation should explain the cost management techniques used to monitor and control the cost and profitability of construction projects, including:

- analysis of interim claims
- cost value comparisons
- management costs
- preparing and examining elemental and project comparison costs.

Plan

- How will I research purchasing techniques to facilitate supply of materials and cost management techniques used to control costs?
- How will I create the presentation with brief descriptions of the techniques?

Do

- Have I completed the presentation in as much detail as possible?
- Can I present some additional ideas on improvements?

Review

- I can explain how I would approach difficult elements differently next time.
- Once I have reflected on my own work and any feedback from others, I will make any necessary changes to my presentation.

C

Develop a programme of activities for construction works

Now you will get the chance to apply what you have learned earlier in this unit to begin planning your own programme of activities, using graphical representations of progress and detailing the timings for critical and non-critical elements of a construction project. You will need to consider and choose the most appropriate methods to monitor your progress.

C1 Production control systems

Production of programmes of activities

The project management team plans the sequence and methods (using Gantt charts, CPA, LOB, etc.) which will be used to complete the project.

The programme of activities needs to be able to be adapted to deal with any unforeseen circumstances to minimise the impact on other areas or stages of the project. It must cover the following areas (see section A2 earlier in this unit):

- ▶ method statements
- ▶ site layout
- ▶ site accommodation and storage
- ▶ Gantt charts, bar charts and linked bar charts to show and monitor progress of the project
- ▶ waste management – although it is no longer a legal requirement to produce a site waste management plan (SWMP) it may still be required to comply with the BRE Environmental Assessment Method (BREEAM) used to assess building sustainability. In any case, it is a good idea to prepare one before construction work starts, identifying the waste which may be produced and to estimate its quantity. This provides an action plan of how to manage each waste product (e.g. reduce, reuse, recycle or disposal).
- ▶ site traffic management – planning permission may require a construction traffic management plan (CTMP) to be completed before major work begins. The plan should identify suitable access roads for the delivery of plant and materials and

identify traffic routes on site to allow the safe movement of plant, reducing the likelihood of accidents. Typical recommendations are:

- separate entrance and exit points for pedestrians and vehicles, with clearly marked and lit walkways for pedestrians
- car parking away from the main work area to reduce movement of vehicles around the site
- only trained and competent personnel should drive or operate vehicles on site
- reversing on site should be kept to a minimum and be supervised. One-way systems and control measures such as mirrors, CCTV cameras and reversing alarms should be used to help reversing
- signage should be clearly displayed around the site to provide clear instructions to pedestrians and drivers of vehicles of the routes and site rules (see Figure 9.9).

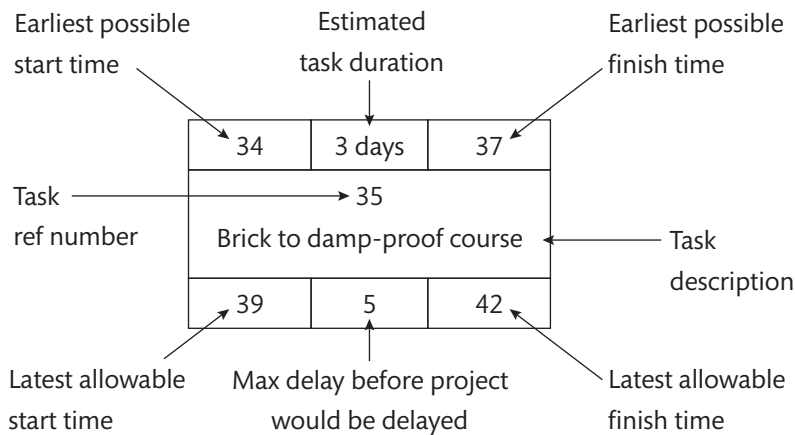


► **Figure 9.9:** This no turning sign helps to protect workers and visitors on the site

Network analysis

Network analysis is a general name given to specific project management techniques such as CPA, precedence diagrams, time change diagrams and line of balance (LOB). The CPA or precedence diagram methods of planning allow project management teams to understand the interdependency of the activities and therefore to determine the effect of a delay that one activity will have on the rest of the project.

Very basic diagrams can be produced manually; however, it is more common, and more useful, to use computer-based methods (see Figure 9.10).



► **Figure 9.10:** A precedence diagram is used in network analysis

Theory into practice

Your manager has asked for a list of the welfare facilities that must be provided under the Construction Design and Management (CDM) Regulations 2015. What are they?

Link

There is more about the use of CPA and LOB earlier in this unit, in section A2.

Theory into practice

Create a programme of activities for the construction of a new house within a 12-week period. Represent the programme using a Gantt chart.

Using your programme of activities represent the activities using a critical path analysis (CPA). Show the interdependency of certain activities and identify the activities on the critical path.

II PAUSE POINT

Can you explain the difference between Gantt charts, critical path analysis and precedence diagrams?

Hint

Look at examples of each network analysis and identify the strengths and weaknesses of each.

Extend

Explain when each method would be used and why.

Case study



The new Scottish Parliament building, situated in the Holyrood area of Edinburgh, was due to be completed in

2001 at a cost of approximately £40 million. It eventually opened in July 2004 at an estimated cost of £430 million. The parliament building was designed by Spanish architect Enric Miralles in partnership with a local architecture firm. (Source: www.parliament.uk)

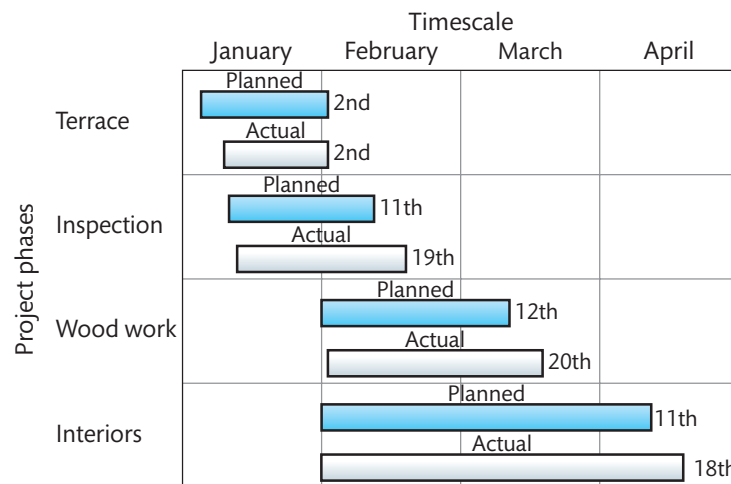
Check your knowledge

- What reasons might have contributed to the project being completed late and ten times over budget?
- What control measures should have been put in place to prevent the project from going so far over budget?

Measurement of progress

When working on site you will need to make sure that you are using an accurate system to measure your progress. The project management team monitors the actual progress of the project against planned progress on a regular basis. Generally, actual progress is measured by one representative from the project management team and one from the main contractor. These measurements are recorded and reported as they can be used for payment of the contractor and to assess the current progress of the project. These reports should:

- ▶ have an up-to-date Gantt chart or network analysis to show actual progress against the planned progress (see Figure 9.11 for an example). They may also include photographs to show evidence of progress
- ▶ highlight any delays, explain the delays and the possible impact on the completion time and cost of the project
- ▶ include proposals of how the lost time may be recovered.



▶ **Figure 9.11:** An example of an actual versus planned Gantt chart

Overcoming the consequences of running ahead of or behind schedule

If the construction project is delayed, the project management team (with the agreement of the client) may issue the contractor with an acceleration agreement. This may incur additional costs but may be necessary when the completion time is critical. Possible options to accelerate the project to recover lost time are to:

- ▶ increase the plant and labour resources on critical activities or tasks
- ▶ review the method statements, looking for alternative safe but faster processes to complete the work

Research

Search on the internet for examples of Gantt charts that show planned versus actual progress.

- ▶ increase working hours, such as evenings and weekends
- ▶ simplify the design specification
- ▶ consider phased completion, i.e. some sections of the project are completed at a time
- ▶ impose a plant booking system, for example on large projects where cranes may be in high demand to reduce delays due to contractors waiting to use the plant.

Network analysis identifies the critical path activities to determine if delays will impact on completion time. Delaying activities not on the critical path will not impact the overall project. If the project is ahead of schedule, it may be necessary to adjust coming activities because resources such as plant, labour and materials may be scheduled for specific arrival times. Network analysis will also show the impact of being ahead of schedule.

If it is possible to move the arrival of the resources forward, this should ensure the project remains ahead of schedule and may be completed early. If it is not possible to adjust the resources it may be necessary to redirect some of them to other projects temporarily.

Causes and effects of delays

Many issues can cause delays, such as poor planning and scheduling, lack of available resources, changes in design, adverse weather and poor site supervision. The consequences of delays can be significant to the final project:

- ▶ Going over time can increase costs for the client. Depending on the cause, the client or contractor may be entitled to compensation payments.
- ▶ Going over budget because of additional work, design changes or accelerating works needs to be paid for.
- ▶ Disputes between various parties over the cause of delays can further hinder the project. These disputes may lead to legal proceedings, which can further delay the project and increase costs significantly.
- ▶ Accidents can occur if work is being rushed.

Delays do frequently occur, so it is helpful that many computer packages allow for rescheduling. It is important to ensure specific constraints on the resources, plant, labour and materials are considered so that it is possible to see the impact on other activities of being ahead or behind the original schedule. Overtime payments to get the project back on track can be a significant cost and should be agreed by all parties in advance, to avoid disputes.

Extensions of time (EoT) applications are submitted by contractors when they feel there is a justifiable reason for a delay, such as changes in design by the client, extreme weather conditions or delays caused by a nominated subcontractor. If the contract administrator approves the application, the contractor is given a later completion date. If it is not approved it is the responsibility of the contractor to take reasonable means to ensure the contract is completed on time.

Theory into practice

Severe weather has put a construction project two weeks behind schedule. What options does the contractor have? What are the consequences of the delay to the parties involved?

Preparation of financial progress information

You will need to prepare several pieces of financial progress information to track the financial progress of the project.

▶ **Table 9.11:** Financial progress information

Financial progress information	Description
Site returns	Accurate records ensure actual costs are recorded and monitored. A daily diary could record where the resources are used each day, or goods received sheets could record each material delivered on site. Any short deliveries or discrepancies are recorded and sent to head office for processing. Supplier invoices are checked against the site record to ensure the quantity is correct. For any problems with deliveries, a credit note can be requested against the invoice. This controls costs from suppliers and checks goods received are of the right quantity and an acceptable standard.
Variations	Changes to the originally agreed contract, for example changes in design, using alternative materials, etc. These can only take place if they have been authorised in writing by the architect. However, the cost of the variations may not be agreed at the same time.
Claims	A request made by a contractor to the client for additional payments for changes or variations to the original contract. These may be due to client delays or for variations requested by the client or for extensions of time.

Link

Another piece of information you must collect includes interim valuations and payments (see Table 9.9).

Reviewing events, predicted and unforeseen

It is crucial to monitor and review the progress regularly. The impact of predicted events such as changes to design and unforeseen events such as extreme weather conditions or unexpected ground conditions should be assessed. These events may affect the completion date and the overall cost of the project. It is important for the project team to be aware of the events and quantify the impact on the project and keep the client informed.



PAUSE POINT

Why is it important to regularly monitor the physical and financial progress of a construction project?

Hint

Think about what can happen when a construction project is poorly managed.

Extend

What methods would you use to monitor the physical and financial progress of a construction project?

Assessment practice 9.3

C.P5

C.P6

C.M5

C.D3

The local property developer was happy with your presentation. She would now like you to produce a report which includes a comprehensive programme of activities for constructing a single detached house. This should include:

- details of the critical and non-critical activities within the programme, presented in a graphical format
- as much detail as possible in terms of timings for each activity
- an explanation of the most appropriate method for monitoring the progress of the project so it is completed on time.

Plan

- How will I find out the types of activities required to build a house, and identify which are critical and non-critical?
- How will I get an idea of realistic timings for these activities?
- Where will I research the various techniques to monitor and control the physical and financial progress of the project?

Do

- Have I completed the report in as much detail as possible?
- Is my report comprehensive enough to be used for a real project?

Review

- Can I explain how I would approach the difficult elements differently next time?
- Once I have reflected on my own work and any feedback, I will make any necessary changes in my report.
- I will be ready to present it to my peers for some additional ideas on improvements.

Further reading and resources

The Construction Industry Knowledge Base: www.designingbuildings.co.uk

Cooke, B. and Williams, P. (2009) *Construction Planning, Programming and Control*, third edition, Chichester: Wiley-Blackwell.

Crown copyright (2013) *Construction Strategy: Industrial Strategy: government and industry in partnership*, URN BIS/13/955, London: Department for Business, Innovation and Skills.

Department for Communities and Local Government (2016) *Public Land for Housing programme 2015–20 Programme Handbook*, London: Department for Communities and Local Government.

Hore, A.V., Kehoe, J.G., McMullan, R. and Penton, M.R. (1997) *Construction 1: Management, Finance, Measurement*, Houndmills: Macmillan.

Lock, D. (2004) *Project Management in Construction*, Aldershot and Burlington, VT: Gower Publishing Limited.

THINK ▶ FUTURE



Troy

Troy is an experienced project manager for a large design company that specialises in hospitals and education facilities. He had worked as a site manager for several years before stepping up to his current post, where he is responsible for four of the company's development sites. His role is to organise and monitor the progress of the projects, from the site investigations to the tendering and appointment of a contractor to undertake the construction work. Troy is involved in all aspects of the projects and even has to appoint architects to commission the design and production drawings.

Troy loves his job. There are so many different people and roles involved within a construction project that no two days are the same. Having to run four projects at the same time means that Troy has to manage his time efficiently to stay on top of all developments. Troy also has excellent IT skills in project management and uses contract programs to co-ordinate information and contractors, and monitor the physical and financial progress on all the sites.

Troy has targets for delivering the projects safely, to the required standard of quality, on time and on budget. This means he regularly has to make decisions that have a financial effect on a project. He has excellent skills in communication and chairs several meetings a week with different contractors and clients. Luckily, Troy has an outgoing personality and gets on with people who he interacts with; he is generally approachable and open to ideas.

Troy enjoys the feeling of completing a project that had some difficulties which have been overcome to produce a quality outcome for the client.

Focusing your skills

A project manager must possess a variety of skills when they are co-ordinating a number of different construction projects.

- Leadership – ability to lead the team as well as manage them and be able to inspire them.
- Negotiation – ability to resolve conflicts and create solutions to difficult situations.
- Time management – ability to schedule work to prevent delays or overruns.
- Cost control – ability to monitor the costs of the project to prevent it going over budget.
- Critical thinking – ability to deal with challenges and delays and find solutions.
- Health and safety management – awareness of the need for high standards of health and safety on site at all times.
- Communication skills – ability to communicate with everyone within the project team.
- Efficiency – with so many projects to manage it is essential to be organised and efficient.

Getting ready for assessment



Hayley is in the second year of her BTEC Extended Diploma in Construction and the Built Environment. For this unit she has been given an assignment that involves preparing a technical report based on the different roles and responsibilities of the project management team, the techniques used to manage the principal resources and the methods used to monitor the quality and progress of a construction project.

Hayley's report should include evidence of her own research; for example, charts showing management structures and the interaction between team members, case studies of methods and techniques to manage resources and to monitor quality and progress.

How I got started

I started this assignment by looking at the sources of information my tutor had provided on the last page of the assignment. These sources are very useful and are a great start to help you research and gather information on helpful features and items.

Then I looked through my notes and put together a list of all the different roles involved in managing a construction project. I made sure to list the responsibilities of each role. I wanted to make sure that my report was meeting all the key verbs within the assessment, so I downloaded a copy of the unit from the specification on the Pearson website which provided clear guidance on what I needed to do.

I carried out a lot of research online and in books to find out as much as I could about the different roles and responsibilities of the project management team, the techniques used to manage the principal resources and the methods used to monitor the quality and progress of a construction project. I wanted to find some interesting case studies, but this was difficult as it's such a huge topic!

How I brought it all together

To start, I wrote a very short introduction explaining the purpose of my report. I remembered my tutor telling us it was important that our introductions outlined what we were planning to say in detail, so I made sure my introduction did this.

After this, I decided to cover each role, and their responsibilities, within a project management team and how the team members interacted with each other. I then wrote a section on each of the principal resources and the techniques used to manage them. For my final section, I wrote about the methods used to monitor the quality and progress of a construction project.

Because I used lots of books and websites to support the points I was making, I put together a bibliography and

references so all my points could be checked. I asked my parents to read over my report to make sure what I was writing was correct and to check for errors. I also proofread it against the assessment criteria to make sure it matched the verbs used from the grading criteria.

What I learned from the experience

I'm glad I had done some work beforehand planning my research and identifying where to look for information. It was hard to find supporting case studies and next time I would try to approach local businesses as well as looking at larger construction companies to try and get more information.

I think I spent a little too much time focused on explaining the roles and responsibilities and not enough time linking them together and evaluating the roles. Next time I would try to spend more time planning my work out, using my notes, to put together a structure for the report before I started writing it.

Think about it

- ▶ Type the assessment criteria into an internet search engine and see if what you find is a good starting point.
- ▶ Where will you find information on management of a construction project?
- ▶ Does the unit content help?