Department of Mechanical Engineering, The University of Hong Kong

BBSE3009 Project Management and Engineering Economics

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Lecture Notes

Site Organisation and Supervision (SOS)

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The coordination and control processes outlined below are essential as they lead to successful completion of construction projects. This function requires constant inspection, communication, testing, planning, programming and reprogramming to achieve the set standard of output and quality. Sound planning is also the cornerstone of effective production management and the contractor ensures that he or she gets the project started on a solid footing and hence prepares adequately before the commencement of production on site.

1. Contractor's Preparation

As soon as the client's tender acceptance letter (or, at times, letter of intent) is received and prior to signing the contract documents/agreement (which at times occurs several weeks later), the successful contractor will start the planning and mobilisation action. The planning required to be undertaken at this stage covers site layout, site operation and the organisation of site staff. These should proceed concurrently, as decisions made on one may affect the others.

1.1 Planning Generally

Planning is a management process which enables successful running of many business activities, including construction projects. In construction projects, planning is concerned with the various methods of arranging, procuring and employing money, materials, men and machines (all of which are known as *resources*) to carry out the day-to-day construction operations on site. It is also a practical attempt to foresee problems before they arise and, hence, avoid events which might prevent the attainment of stated project objectives, namely the completion of construction project within a fixed timescale, safely, economically and to specified quality levels.

1.2 Construction Project Planning

Construction project planning is primarily about thinking ahead and therefore entails predicting the working method to be employed, resources to be utilised, when certain events should happen, duration of activity and so forth. There is always a certain amount of risk associated with all predictions and one approach to the reduction of the risk is to get as many people as possible involved in the planning. For this reason, the contractor creates a broad planning dialogue in which persons such as managers and senior personnel (especially those who will be closely associated with the project) are drawn into the planning process and are also made to feel responsible for their respective contributions. In addition, as an effective line of communication is also of great importance at this stage, the contractor arranges a formal pre-contract meeting to discuss the various contract requirements, production planning, delegation of responsibilities, establishment of lines of communication and so on. Generally, at this stage, production planning is concerned with completing the construction project in the shortest possible time compatible with quality, technology, economy, legal, social and safety parameters.

Planning must also build on a clear division of the project into stages. For this reason, the contractor commences the planning process by analysing the project and defining the tasks to be executed. What determines the size of individual tasks are factors such as manageable proportions, resource availability, speed of production, room for manoeuvring, external circumstances and the like. In the process, the contractor transforms the drawings and measured works section of the bills of quantities into a number of construction operations, tasks or activities. These operations, tasks or activities form the basis of a method statement and are also incorporated into the contract programme.

1.3 Method Statement

A *method statement* is a detailed assessment and narrative of the construction methods to be adopted

on a construction project. It involves turning the drawings and bills of quantities into a number of construction operations, tasks or activities and detailing a suitable method of carrying out every operation, the duration and the combinations of equipment and labour power. This should correspond in all respects to the contract programme.

In this technological age, computer software is available for use to save time and resources required in carrying out this exercise. A contractor who has this facility therefore, normally feeds information on the construction project into a computer and it expediently works out programmes, critical paths, float and so forth.

Generally, the information contained in method statements is used for compiling the bid estimate and, hence, is normally prepared at the tender stage (see Table 1). For this reason, it would be appropriate to assume that the preparation of a pre-contract method statement entails adjusting, updating and finalising the pre-tender method statement for use in planning and programming the works. However, where no method statement exists, one is prepared by the contractor on the award of the contract, and decisions on labour and plant requirements are made by those who will be responsible for managing the project and providing resources (e.g. planning/contract manager, programming personnel, site manager and plant manager). The method statement should contain all the relevant information on the operation such as work stage, quantity of work, method of construction, output, plant summary and duration. It must also be in a format which depicts the general sequence in which the various tasks are to be carried out, and if it is to be presented to the client, it will also include safety aspects of production.

Table 1. Example of a method statement

Description of items	Quantity	Details of method	Plant	Output per week	Plant labour involved	Period required
Excavate pipe trench	500 m	Excavate backfill plant	Backacter	500 m	4 labourers	1 week
PVC pipe	500 m	Lower by hand	Nil	250 m	6 labourers	2 weeks
Basement excavation	4,000 m^3	Excavate direct load to lorry	Backactor and lorry	2,000 m^3	2 labourers	2 weeks
Basement reinforcement	5,000 kg	Supplier cut and bent	Nil	1,666 kg	2 steel fixers	3 weeks
Basement concrete	400 m^3	Site mixed	14/10 mixer	100 m^3	6 concretors	4 weeks

On completion, the method statement should be able to convey to its users the planned execution of the works. Furthermore, it should prove an indispensable tool for use by the planning and programming personnel in the preparation of the contract programme and also by the site manager for organising and managing the daily site operations.

Besides pulling together managerial experiences on production methods and effective utilisation of resources at tender stage, the method statement at the precontract planning stage offers the contractor other benefits, as follows:

- It coordinates the efforts of the contractor's site management team in their determination to get the project completed efficiently, economically and on time using an agreed method or sequence of work.
- It provides each section of the contractor's establishment with detailed information on construction.
- It enables data concerning new construction technique and effective methods of handling materials/components to be included in the project planning.
- It allows a realistic comparison of output and duration of different methods, machines and combination of personnel/machines and, hence, facilitates the choice of optimum production

method.

- It permits the plant requirements for the construction project to be scheduled for procurement by the plant department.
- It acts as a feedback system for the contractor's estimating department.

1.4 Contract Programme

As soon as the contract is awarded, the successful contractor prepares a suitable programme to enable the works to be carried out in an orderly and efficient manner. The contractor's programme normally consists of a statement of intended construction operations set in a logical order to assist the smooth running of the project. The programme also facilitates the identification and avoidance of potential production problems. A careful study and planning of the various construction operations are prerequisite for the production of a suitable programme which shows all the operations (e.g. what activity should happen, when it should happen and by whom it is carried out; how long it takes and how all activities dovetail together - see Figure 1). In effect, the programme must show sufficient detail in terms of timing and duration of operations, dates for delivery of materials/components, labour resource requirements and subcontractors site commencement and completion dates. It should also identify the critical path.

Contract: XYZ Development Project														
Activities	**Time in months**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Site preparation/set-up	====	==												
Sub-structure		====	====	====	==									
Drainage		=	====	====	==									
R.C. frame				====	====	====								
Masonry						==	====	==						
Cladding							==	====	==					
Services					====	====	====	====	====	==				
Roof covering								====	====	===				
Partitions						==	====	====	====	====				
Carpentry/joinery						==	==			====	====	====	=	
Internal finishings												====	====	
Glazing												==	===	
Painting					==	====	====	==					====	
External works										==	====	====	====	=
Site clearance														====

Figure 1. Example of a master programme

Generally, the construction programme is developed by the contractor from the programme prepared at the pre-tender stage and serves the following purposes to the contractor's site management team:

- Depiction of visual instruction and forming the basis of controlling all site operations.
- Provision of yardstick for progressing, controlling, reviewing and costing.
- Showing the sequence necessary for carrying out an operation, the duration and the total output required of resources employed.
- Providing the client with an indication of its periodic financial commitments.
- Enabling the non-productive time of both men and machines to be identified, controlled and minimised where possible.
- Exposing, where foreseeable, likely difficulties and delays in the future and facilitating the

institution of corrective measures to overcome them.
- Discouraging design changes as the programme depicts the natural consequences flowing from actions.
- Indicating at what stage, during production, the contractor would require design information from the architect.

The overall/master project programme is a document which breaks down site activities and hence, enables the identification of the total work content of the construction project. Moreover, it covers the entire contract period and includes all operations in broad terms. The resulting set of operations are quantified and then phased using either simple bar charts (for simple construction projects) or network techniques (for more complex construction projects). Where bar chart technique is adopted, time is usually plotted in months and weeks; dates and contract week numbers are entered and holiday periods are also indicated to show lost production in the programme.

The overall/master project programming is carried out by the contractor's central planning department in consultation with the site manager and contracts manager, but the detailing is sometimes prepared by the site manager under the supervision of the contracts manager. The consultation and liaison with both the site manager and the contracts manager is important as they will be responsible for interpreting the programme into a series of short-term programmes during the production phase of the construction project

1.5 Site Layout

Site layout involves the study, planning and organisation of the unused areas of site around the proposed development to accommodate the contractor's construction equipment, materials and buildings for use in the execution of the construction works. The siting and/or arrangement of temporary buildings, plant and so forth may be influenced by one or more of the following factors:

- Type of construction project (e.g. low-rise or high-rise structure) and method of production envisaged.
- Size, shape and extent of proposed works.
- Size and shape of site and the area to be covered by the proposed works.
- Position of existing obstructions (e.g. existing services and structures) and hazards such as gas mains and underground or overhead electric cables.
- Accessibility to and restrictions within the site.
- Type and size of construction plant and equipment planned for use.
- Proximity of site boundary to existing buildings.

A site layout may be worked out using a plan of the site showing an outline of the proposed building(s), roads, paths, pavings and the like. The proposed route of main service runs is usually marked to avoid placing temporary building or plant over this route. Existing buildings, services, trees and other obstructions on site should be noted on the site plan. In particular, the names of all statutory authorities whose services run across the site should be noted, and, where necessary, they should be contacted for details and location of any services that cross the site but have not been shown on the site plan.

One of the primary considerations for site layout is the need to keep the construction production moving at all times by maintaining a means of access to the site and facilitating an adequate flow of traffic. However, of most importance is the consideration given to the most critical or difficult operation on the site, and this should be the prime factor deciding the layout. In addition, there is also the need to pay regard to methods of unloading during the operation and the vehicle turning circle. The following group of items will need to be considered in the development of site layout.

Temporary buildings

The number, type and size of temporary buildings depend on the extent of the construction project, the client's requirements, minimum statutory requirements and contract period. Temporary buildings are now available in many forms, sizes and makes; however, the contractor's selection should aim at provision of a proper working environment, and privacy to reflect the status of the occupant.

Temporary buildings can be hired or purchased and contractors normally consider factors such as size, ease of erection and dismantling, adaptability, weather tightness, life expectancy, thermal conductivity and ease/cost of transporting to and from site. When taking decisions regarding their acquisition the temporary buildings which are required on most sites include the following:

- *Offices*: The siting/arrangement of site offices takes account of the interrelationship between members of the site management team. The size of office space provided will depend on the number of site staff (for example, in some countries, each office worker is provided with 3.7 m^2 of floor space). The office should have separate sanitary conveniences for each sex at the rate of one per twenty-five persons and washing facilities should also be provided. In addition, offices should be equipped with desks, chairs, plan chests, storage containers, telephones and the like where necessary. Provision should also be made for adequate fire escape routes, first aid, lighting and means of cooling/heating.

  Generally, offices are provided to the following groups of site staff:

  (a) The site manager/agent. This office provides all site/construction information and, hence, is the control centre of the site. Therefore, ideally, it must be placed at a vantage point so as to provide a good view of the site and also to facilitate checking, supervision and security.
  (b) General staff - these include site engineers, surveyors, administration support clerks, safety officers and so on.
  (c) Clerk of works, resident engineer and/or architect (where stipulated) - a separate telephone service may be required, together with adequate mess facilities.

- *Welfare building*: This is the building to which operatives and site staff retire to eat their meals during the lunch break. There must be facilities for warming meals and boiling water and, for this reason, on large sites, canteen facilities are sometimes provided. The size and extent of the site canteen and mess facilities for operatives is mainly dependent upon the extent, location and number of operatives employed on the project. The siting of the canteen is normally influenced by the time taken by operatives to get to the canteen from their places of work, position of site services (gas, electricity and water), access for delivery of food stuff and removal of kitchen waste.

- *Drying rooms*: Drying rooms and lockers are provided for drying and storing operatives' clothes. Ideally these rooms should be located close to the canteen so that clothes can be dried out during lunch break where necessary. Moreover, these rooms should be adequate to enable operatives to put on and remove protective clothing.

- *Sanitary conveniences*: Sanitary conveniences and washing facilities are also provided for the site operatives. The number of sanitary conveniences provided depends upon the maximum number of operatives on site at any one time, and again its provision is at the rate of one per twenty-five operatives. The siting of the sanitary conveniences is to some extent dependent upon the position of available drain connections and the facility normally includes hot and cold water, towels and soap. On sites without drainage connection, portable chemical toilets (cleaned out weekly) can be provided for usage.

Material storage areas

Material storage and work areas for site operations will need to be marked out clearly for the various materials and operations. Storage or a secure store is necessary for valuable items which may be stolen if not adequately stored away and protected. Furthermore, a weather-proof store will be needed for materials which may deteriorate due to the effects of weather. Open storage areas are also required for materials such as bricks, timber, scaffold, precast concrete units and drainage goods.

Location of plant

The location of major items of static plant such as hoists, tower cranes or the space for parking mobile plant are given careful consideration. The storage compound for tower cranes, for example, are so arranged that its radius covers the maximum area of the site. This arrangement enables it to be used for unloading items from delivery lorries into storage areas as well as hoisting items from store onto workplaces or the structure. Particular regard is also paid to erection and dismantling of the tower crane. In addition, rights of airspace and over-rail agreements are considered in relation to site boundaries where necessary.

The other major item of static plant is the concrete/mortar mixing equipment. These are always an attraction to vandals and therefore night storage areas and/or watching will be required for these items of plant.

Temporary roads, hardstanding and access

The provision of temporary roads for the movement of plant and materials is an important issue which requires care and attention. Ideally, where possible, the temporary roads are planned to follow the layout of the permanent road to effect savings on resources in the road construction. Hardstanding may be required for static plant such as tower cranes undertaking lifting operations. Moreover, the provision of sufficient car parking should not be overlooked by the site planner as most operatives, management, site staff and visitors normally arrive on site by car and, hence, require parking space on site for their vehicles.

Sundry points

The following items also require consideration:

- *Stand pipes* should be located close to a mixer or where most required.
- *Site name boards* should be located in prominent positions to identify the site. However, often the positions of site name boards are dictated by the client.
- *Vehicle wash areas* are required to prevent the site mud spreading onto the highway.

1.6 Schedule of Resources

Prior to commencement of site operations – and in addition to the method statement, contract programme and site layout plan – the contractor prepares a *resources schedule*. The schedule is composed of plant, labour and material requirements and the following are considered in most schedules of resources.

Plant schedule

The plant schedule consists of a list of major plant items required for the construction project. At this stage of the construction process, it is essential to reconcile the cycle of equipment usage with decisions made at the pre-tender stage (i.e. the method statement). Decision is also made on whether to hire or purchase an item of plant/equipment for the project (especially where the contractor does not own the required plant/equipment).

Staff schedule

The staff schedule comprises a number of key management, technical and clerical personnel allocated to a construction project. This schedule is normally presented in a form of site organisation structure chart to keep all concerned informed of their authority, responsibility and the channels of communication. Where, owing to under-capacity, suitable staff cannot be found within the contractor's establishment for the required positions, a decision may be taken to engage new staff on a temporary or permanent basis.

Labour requirement schedule

The labour schedule consists of a list of operatives required for the construction works, including gang sizes required for each of the site activities. This schedule could list the contractor's own operatives transferred from other sites or, on the other hand, operatives could be recruited from job centres or hired from specialist labour-only companies or sub-contractors.

Materials schedule

The materials schedule includes a list of all the main materials/components required for the construction project. The items listed have been extracted from the bills of quantities, drawings and the specification and are ready for orders to be placed. The various dates for placing orders may be obtained from a master programme and the contractor's buying department normally places orders as and when required with the suppliers who provided the most competitive quotation and/or whose prices were used in the tender estimate. The ability to supply the material/components on time and to meet the construction programme must also be a consideration.

Schedule of sub-contractor's work

This is composed of a list of nominated/named sub-contractor's and domestic subcontractor's work. These are arranged in order of dates to show when a particular sub-contractor's input is required on site.

1.7 Sundry Arrangements

As careful planning at this stage is essential for the smooth commencement and administration of the construction project, the contractor pays particular regard to the following:

- *Detail drawing requirements*: All required drawings and any other construction information are scheduled, giving dates by which they are required. The contractor forwards this schedule to the architect immediately for action.
- *Temporary site services*: Information is obtained on positions of existing underground services (e.g. gas, water, electricity) in order to protect them during the site operations. The contractor also arranges for the supply of all temporary services (e.g. water, electricity and telephone) required for the execution of the works.
- *Insurances*: Arrangements are made for the procurement of all insurances required under the contract (e.g. employer's liability insurance, insurance against injury, loss or damage and so on).
- *Licences, permits and notices*: Licences required for hoardings, gantry and the like and also permits required for road closures, skips and catering facilities on site are obtained. The contractor also gives the required notices to the area local authority and the police before the commencement of the works.

Generally, the objective of all the foregoing planning and preparatory work by the contractor is to provide the best working environment and conditions which leads to safe, efficient and economic

production of the client's project. In many instances, the above moves are legal/statutory requirements.

2. Site Production

2.1 Setting Up the Site

At this stage, it is assumed that the contractor has taken possession of the site and has started the initial site preparation and setting out, followed by preparation of a site grid, recording of site levels, establishing the site boundaries and the like. After these initial operations, all the required temporary buildings, administration files and stationery, first aid facilities and so on will be brought onto the site. Also of great importance is the control of site communication process which involve the receipt, recording, distributing, storing and retrieving letters, drawings and other written information on site. This process also covers the determination of what telephone calls to record, the mode of recording and those not worthy of recording.

2.2 Project Administration

The administration of the project is the collective responsibility of the project team, made up of the architect, quantity surveyor, structural engineer, building services engineer and contractor (see Figure 2). There are five site personnel that will need more description.

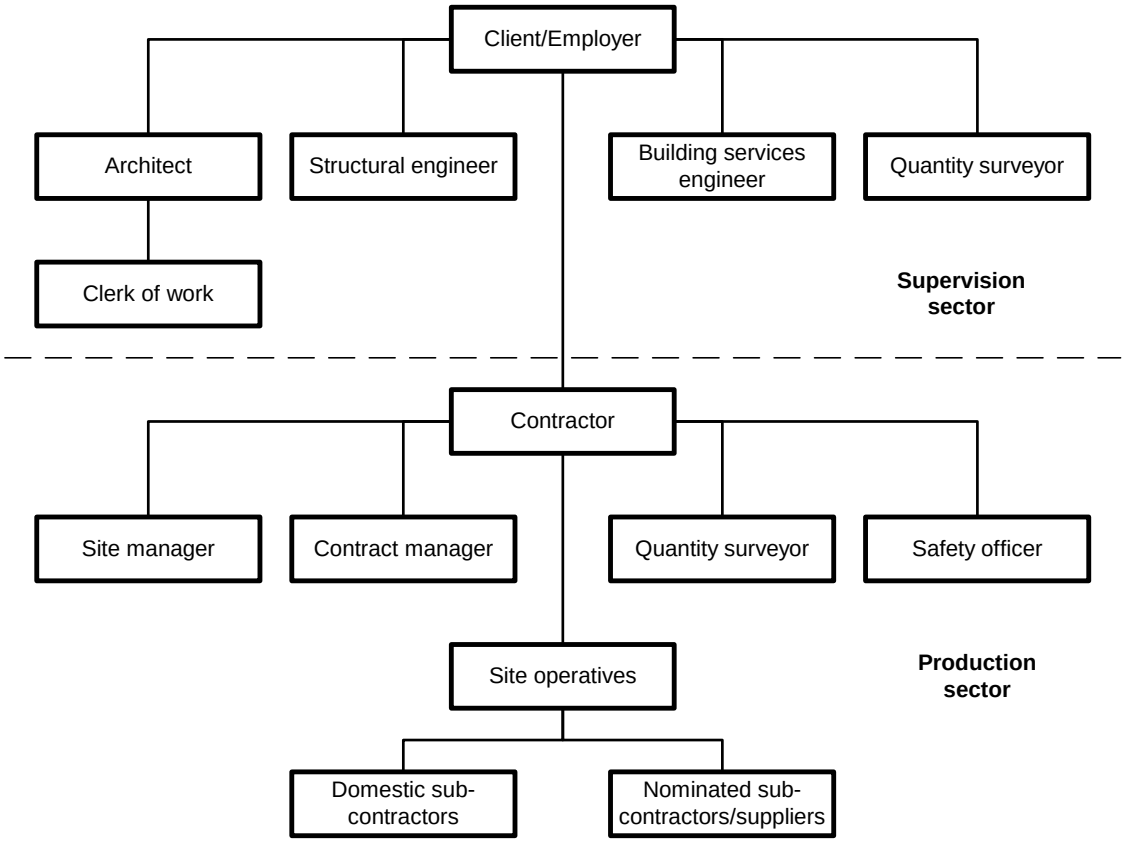

Figure 2. Project organisation structure at the production phase

Clerk of works

The clerk of works is a quality inspector for a construction project during its production phase. He or

she is usually appointed by the client, with the main duty of ensuring compliance with the contract in regard to the quality of materials/ components and workmanship expended in the construction process. Ideally, the clerk of works should be appointed sufficiently early to enable him or her to become familiarised with the contract documentation and procedures before site production commences. Being on site most times, the clerk of works has the opportunity of inspecting any part of the works under construction any time before it is covered up. The clerk of works is responsible for checking the site grid and setting out, inspecting materials/components upon delivery and testing or submitting for testing any materials to be used in the works. In addition, he or she also informs the architect from time to time of any outstanding information required by the contractor as well as any discrepancy in the documentation. The clerk of works also endorses daywork sheets, assists the client's quantity surveyor with site measurement, and keeps records of progress of the project, working conditions and weather, delays, verbal instruction of the architect, site labour employed and visitors to the site.

Being in charge of quality matters, the clerk of works establishes the standard of workmanship laid down in the contract documentation and ensures that the contractor achieves the specified standard without any reduction in the quality of the work.

Contracts manager

The contracts manager is a contractor's representative responsible for the management of production of the construction project. The contracts manager is the key person upon whom the success or failure of the entire site production activities lies and, hence, takes an active part in the planning, programming and controlling of projects in his or her charge.

The contracts manager's responsibilities are many and may include the following:

- Preparing the site layout plan and organising the commencement of work by the programmed date.
- Examining the tender to determine the adequacy of working method and welfare facilities planned.
- Finalising appropriate order and safe methods of working; and allocating responsibilities to sub-contractors and trade supervisors.
- Ensuring that site production progresses as planned and instituting corrective measures if production targets are not met.
- Ensuring effective utilisation of contractor's time and resources on site.
- Preparing cost forecasts of site resources (e.g. labour, plant and materials), their utilisation and deviations for analysis by the quantity surveyor.
- Ensuring that all sub-contract trades are progressing smoothly.
- Issuing all necessary contract notices and letters.

Site agent/manager

The site manager is the contractor's employee and is in charge of directly managing the site operations. The site manager spends most of his or her time on the site talking to supervisors about technical construction matters, and is therefore mostly concerned with coordinating the people directly involved in the performance of construction tasks and welding together effective production teams. He or she is responsible for the day-to-day site operational decisions. These tasks are performed without reference to senior management at head office. Decisions are made on the basis of his or her own personal knowledge and often in response to some particular problem necessitating immediate action. In addition, the site manager is responsible for overseeing that all construction regulations are observed and reporting any defects in plant or equipment to the contracts manager. He or she also carries out periodic checks on the condition of site accommodation and plant, and chases up orders for material, plant and equipment. Above all, the site agent/manager is at the heart of the site operations.

Safety officer

The safety officer, a full-time employee of the contractor, is responsible for carrying out and regulating the contractor's safety policy. He or she is a trained and experienced person with detailed knowledge of all the appropriate construction safety legislations. The safety officer advises management on any legislative and legal requirements affecting safety in construction and any subsequent changes. He or she also advises on measures to be adopted to promote safe working methods and supervises the recording and analysis of information on injuries, damage and production loss. Above all, the safety officer must regularly assess and ensure the maintenance of the site safety standards.

Contractor's quantity surveyor

The contractor's quantity surveyor is the construction professional who carries out the quantity surveying functions in the contractor's establishment. The range of tasks performed by the contractor's quantity surveyor are somewhat different from those of the client's quantity surveyor. The contractor's quantity surveyor's roles vary from company to company in accordance with a particular company's size, policy and requirements. Generally, the contractor's quantity surveyor is more commercially minded and largely represents the contractor's interests in terms of the profitability of construction projects undertaken. For this reason, he or she ensures that appropriate measures are taken to make the construction project under his or her care a financial success.

General

The above-mentioned personnel perform their respective roles on the construction project and contribute towards the achievement of the client's development aims. The architect, who is traditionally the project team leader, ensures that all the participants are pulling in one direction and any conflict which threatens the objective of the project is dealt with immediately. Moreover, the architect will try to diffuse any tension in order to avoid protracted contractual disputes, and to ensure that all contractual matters are dealt with in the proper manner.

3. Contractor’s Control Process

Contractor's control over the execution of the projects takes several forms and generally its extent depends on the size, nature and complexity of the particular construction project, contractor's skill and organisational and control policies. However, whatever the determining factors, the objectives and principles of control are the same; that is, to measure progress or result against a predetermined standard. The planning and programming establish the standard against which site progress will be measured and, to achieve effective control, the contractor ensures that resources for the construction of the project are efficiently combined and the production constantly monitored (see Figure 3).

The monitoring cycle starts with measuring the actual output and comparing it against the planned performance. When this exercise reveals deviation, the causes of the deviation are analysed and corrective measures devised and implemented to correct the variance. The cycle is repeated by measuring the revised performance and comparing it to the standard. The process is repeated and the appropriate measures adopted until the planned performance is achieved. The desired result of this control is judged in quantity, quality and safety aspects of production. Also, the economy of production depends on the establishment of effective site control to achieve proper allocation of well defined tasks, setting of targets and making sure that the targets are not lost by reason of:

- Poor performance.
- Use of unplanned or unspecified production method.
- Use of untrained or inefficient operatives.

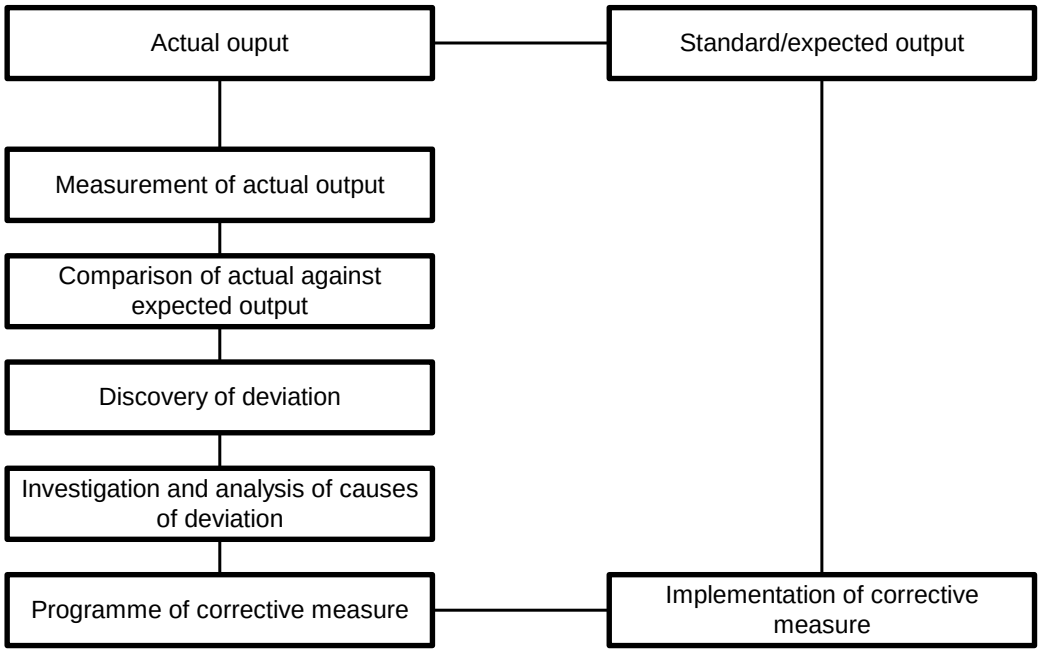

Figure 3. The control process

3.1 Areas of Control

The primary control areas are usually developed in the project planning phase and they include: labour, sub-contractors, productivity, materials, plant and quality standards

Labour

The amount of labour required for each item of work on a project can be assessed from the contractor's programme and the site manager, in conjunction with the trades supervisors, is responsible for the engagement, direction and control of operatives. The control of labour involves a constant check on operatives' performance in comparison with targets set for payment. This is achieved by the use of a weekly labour employment sheet on which the operatives' achieved target has been recorded. The record of performance, compared to those set, facilitates the calculation of operatives' earned bonus and weekly earnings. The success of this procedure depends on the accuracy of recording the operatives' daily output.

Table 2. Typical trade on a construction site

Labourer	Plasterer	Marine craft crew
Excavator	Terrazzo/Granolithic tiler	Stevedore
Concreter	Glazier	Suveryor/Leveller
Bricklayer	Painter	Chainman
Drainlayer/Mainlayer	Electrician (Wireman)	Rigger
Mason	Plant operator	Piling worker
Steel bender/fixer	Vehicle driver	Shotfirer
Blacksmith	Pneumatic driller	Tunnel worker
Carpenter/Jointer	Bamboo worker/scaffolder	Security staff/watchman
Plumber	Structural steel erector	Contractor’s site staff
Diver	Lift worker	Fitter/Mechanic
Diver’s lineman	Welder	Caisson worker

Sub-contractors

A sub-contractor, whether domestic or labour only, must be controlled to give increased output in order to meet the project's objective. Nominated subcontractors, on the other hand, must be influenced to cooperate and do their best not to frustrate the efforts of operatives in other trades. To achieve this aim, all relevant project information must be speedily passed to the nominated subcontractors concerned. Also, all their attendance requirements should be provided quickly and they should be encouraged to communicate among themselves to facilitate the solution of site problems.

Productivity

Increased competition for a share of the construction market necessitates economy of production, which means high levels of productivity. For this reason the contractor needs to employ work study and operational research techniques in order to establish productivity standards and better working patterns. These techniques may be summarised as follows:

- *Work study*: The work study technique is composed of method study and work measurement. Method study seeks to improve production methods by the adoption and application of:

  (a) Better site layout and construction methods.
  (b) Effective equipment and handling techniques.
  (c) Better working conditions.

- And work measurement seeks to establish the basis of comparison and control to facilitate effective programming by undertaking:

  (a) Assessment of performance of labour and plant.
  (b) Application of costs to expected performance.

Materials

The basis of material control is a materials schedule which itemises all the materials necessary to complete a project. In addition to ensure that the right quantity of materials is purchased, the contractor's buyers should derive the required quantities of materials by measuring from the architect's drawings. Apart from the main objective of establishing the right quantities of materials, this exercise serves as a check against the amount of materials contained in the bills of quantities.

The next approach to material control is the preparation of a materials checklist for delivery, maintenance of reliable delivery record and inspection and checking quantity/quality of key materials. There must also be control over waste during use of material for the works. Moreover, as a check of how successful the implementation of material control was on a project, a final material reconciliation should be carried out at the end of the project. This exercise involves comparison of total materials purchased for the project, less those retained or resold against actual quantities incorporated into the works.

Plant

The employment of plant in construction work reduces the amount of physical energy required in the execution of some operations. It also accelerates the pace of the construction process as it facilitates the execution of some mundane work of lifting heavy materials and transporting. As the contractor requires the use of plant in the execution of some sections of the project, it is therefore essential that he or she keeps records of all the up-to-date plants for construction works.

Plant hire or ownership is subject to a rate for its hire. When a plant department supplies its own company, it does so on the basis that the contract account will be charged on a weekly or hourly rate.

This hire rate can be expensive and the contractor should control its effective utilisation once an item of plant is acquired. Economic utilisation of plant depends on:

- Sufficiency of work available to keep the plant in maximum working capacity during the period of acquisition.
- Experienced and skilled plant operators.
- Matching capacities of all plants to avoid under-utilisation due to mis-match of plant capacities.
- Careful planning and continuous programming of work to reduce wasteful idle standing time.
- Good maintenance of the plant.
- Selecting correct plant for the work.
- State of health and motivation of plant operators.

The above is an indication that, in the plant control process, the contractor adheres to the factors listed to ensure that plant time is not wasted. In addition, the plant control process extends to the recording of the delivery and installation of plant on site, maintenance, servicing and repairs. Equally important is the necessity to return all items of hired plant as soon as it becomes redundant on site.

Quality standards

During the design phase, it is the responsibility of the designer to ensure that quality is attained to the satisfaction of the client. Therefore, matters concerning quality are set out in the conditions of agreement between the client and the contractor. Also, quality standards which the contractor is required to achieve are specified in the contract documentation. The purpose of setting the standard is to produce a practical, factual and measurable limit as an object.

- Employment of skilled operatives with technological know how and who will exercise care in the execution of the works.
- Use of specified materials and components which are adequately tested, carefully stored and protected.
- Effective planning and programming of the works and controlled use of resources (i.e. plant, materials and operatives).
- Periodic inspection by site management and communicating inspection result to operatives.
- Adequate and effective protection of completed work.

At the production phase, the achievement of the quality standard specified becomes one of the pressing requirements of the construction project. Although several project participants with diverse specific interest and terms of reference are responsible for inspection, testing and approving various matters concerning quality, the contractor is responsible for the production of a quality product and, for this reason, has a duty to inspect and maintain a high standard of work.

[Review Questions]

(1) What is construction project planning and what are the major considerations?

(2) Briefly explain the functions of method statement and contract programme?

(3) What are the important schedules of resources needed for monitoring site operation?

(4) Briefly explain the role and duties of the five site personnel common in a building project.

(5) What are the important control areas for a contractor to operate effectively on site?

References

Kwakye, A. A., 1997. *Construction Project Administration in Practice*, Chp. 9, Longman, Harlow, Essex. [624.068 K98 c]

Tang, S. L., et al., 2003. *Modern Construction Project Management*, 2nd ed., Chp. 9, Hong Kong University Press, Hong Kong. [624.068 M689][ebook]

Web Links

Case Study: HKU Kadoorie Biological Sciences Building (the section on Site Planning)
http://civcal.media.hku.hk/biosci/default.htm

Case Study: HKU Medical Complex (the section on Site Planning)
http://civcal.media.hku.hk/medical/default.htm

Case Study: 2-storey Prefabricated Building at HKU (the section on Site Planning)
http://civcal.media.hku.hk/prefab/default.htm

Ishikawa diagram - Wikipedia, http://en.wikipedia.org/wiki/Ishikawa_diagram

Ishikawa-Diagram
http://gc21.inwent.org/ibt/en/ilt/ibt/regionalportale/sadc/downloads/ishikawa_diagram.pdf