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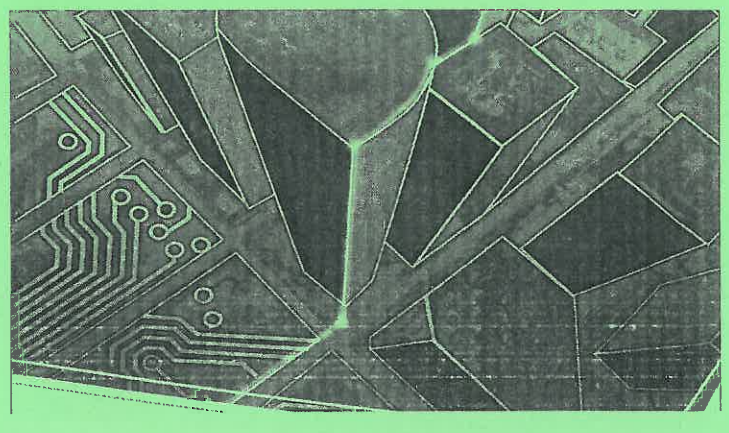
Technology for tomorrow

Department of Building & Human Settlement Development
North Campus

Construction Management III
DCO3010

Module 1



DEPARTMENT OF BUILDING AND QUANTITY SURVEYING

CONSTRUCTION MANAGEMENT 3

DCO 3010

MODULE 1

PLANNING

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PLANNING AND PROGRAMMING

INTRODUCTION

As the building industry has become intensely competitive and professional since the early 1970's and the contract duration times have been reduced it is now essential that contractors Plan and Programme their work effectively.

Planning is the work a manager performs to predetermine a future course of action.

Programming is the use of techniques to time schedules and co-ordinate this course of action.

The purposes of a programme are:

(a) To table agreed contract start/completion dates with the Architect representing client.

(b) To construct a time table for the co-ordination of management on site.
   1. Requisitioning of orders
   2. Delivery of materials
   3. Start/finish dates of sub-contractors
   4. Issuing of relevant information for the Design Team (Architects, Engineers)
   5. Plant usage and requirements.

(c) Relate the sequence of Construction Events.

(d) Tabulate the required outputs from Labour and Plant.

(e) Form the basis of budgets and cash flow forecasts.

(f) Measure actual progress against anticipated progress.

PROGRAMMING WITH BAR CHARTS

INTRODUCTION

In the early 1900's Frederick W. Taylor and Henry L. Gantt developed a graphic representation of work – versus – time. These graphic representations are still the basis for our modern 'Bar charts' or 'Gantt charts'. This early work was the first recorded method of work scheduling and was swiftly adapted for construction planning and progress measurement. The bar chart is an excellent method of representing construction activity and is easily read and understood by management and site staff.

1. What is a Bar Chart?

A bar chart is a graphic (diagrammatic) representation of construction activities plotted against time allowed. In its simplest form let us consider the building of a garden wall.

The duration of a construction activity (in days) is indicated by the length of a 'bar" on a bar chart. In this particular programme the start of each activity is strictly controlled by the completion of the preceding activity. The only overlapping activity is the removal of rubble which can begin during construction.

In large more complex building contracts the bar charts are also larger and more complex but the basic principles are constant.

2. How is the length of each 'bar determined?

The total quantity of work to be done on an activity must be determined and be divided by the production rate (quantity or volume of work per day) of a predetermined number of the workers to be used during the activity. The result will indicate the number of days.

Example:
Excavate the garden wall foundation.
Work to be done = 20m long x 0,60m wide x 0,500 deep = 6 m^3
2 labourers will be used to dig at a production rate of 1m^3 person per day, therefore the team of 2 persons can dig 2 m^3 per day.
∴ Activity duration 6m^3 ÷ 2m^3 per day (1m^3 per person x 2persons) = 3 days.

Circumstances may be such that only 2 days are available for excavating and the production rate must then be increased to get the work done within the two (2) days.

Required production rate = 6m^3 ÷ 2 days = 3m^3 per day.

At a work rate of 1 m^3 per person ÷ 1m^3 per person per day, 3 persons will be required to complete the work in 2 days.

This output information and labour requirement can also be recorded on the Bar Chart:

This form of representing labour requirement is effective but tends to complicate the programme. A separate system of recording labour can be used and is called the 'resource aggregation chart' or a labour histogram, indicating the total number of labourers on a daily/weekly basis.

Based on the above example draw a resource aggregation chart indicating the number of bricklayers required.

4. **There are two basic types of bar-chart programmes.**

1. Master Programme
2. Section Programme

4.1 **A Master Programme** is the overall controlling programme and does not go into great detail with regard to construction techniques and activities. Its duration is the overall contract period from start to finish.

4.2 **A Section Programme** is a short term program which breaks down a construction even (e.g. construction of concrete columns), into a sequence of detail job activities (e.g. fix column reinforcing steel, put up shutters, pour concrete, cure concrete). 'Resource Aggregation' or 'Labour Scheduling' is often performed at this planning stage. It is important to note that for accurate 'labour scheduling' every activity on a construction programme must be considered.

5. **Recording progress on a bar chart**

We have already learnt that one of the criteria for the successful completion of a contract is its timeous handover. Any client who prepares to be in a new building by a certain date and is only given occupation 3 months later will be unlikely to trust the architect /builder with any future work. The sooner a builder completes a contract the more likely he is to make a good profit and secure future contracts.

One of the simplest and most effective ways of assessing progress is against a bar chart programme. A bar chart is a forecast of how much work a contractor must do during a certain period (daily/weekly/monthly) in order to complete the contract on time. If a forecasted activity in foundation works is supposed to take 6 weeks and the contractor takes 8 weeks to complete the activity then the contractor will be 2 weeks behind programme in that section of the programme. The actual progress against forecasted/expected progress can be recorded on the bar chart as follows:

Advantages of a Bar Chart

1. Simple format
2. Readily understood
3. Can show actual performance against expected performance
4. Can indicate labour/material resource requirements
5. Key dates such as dates for material delivery and sub-contractors' work are easily recorded.

Disadvantage of a Bar Chart

1. Complex, inter-related activities cannot be identified.
2. No emphasis on critical construction activities.

Tutorial

1. Draw a bar chart for a simple garage with the following information:

Contract period	4 weeks	
Construction activities	Excavations	$30m^3$
	Concrete foundations	$15m^3$
	Brickwork 10 000 bricks	
	Concrete to floor	$7m^3$
	Roof structure	$40m^2$
	Plaster	$100m^2$
	Plant	$100m^2$
Construction outputs	1 labourer excavates 1m3 per day	
	1 bricklayer lays 700 bricks per day	
	1 plasterer plasters $25m^2$ per day	
	1 carpenter constructs $15m^2$ roof per day	
Gang sizes	1 painter paints $65m^2$ per day	
	Each bricklayer has 1½ labourers	
	Each carpenter has 2 labourers	

PROGRAMMING USING NETWORK TECHNIQUES

HOW DID NETWORK TECHNIQUES DEVELOP?

In 1958 PERT (Programme Evaluation Review Technique) was developed by the Programme Evaluation Branch of the U.S. Navy Special Projects Office with the assistance of management consultant (Booz-Allen and Hamelton) and the Lockheed Missile System.

In the 1957 Morgan R. Walker of E.I. du Pont de Memount Co and James E. Kelly of Remmington Rand introduced the CPM (Critical Path Method), to the du Pont factory and reduced plant "down time" from an expected 125 hours 78 hours saving 1 000 000 in hours the first year of use.

PERT (Programme Evaluation Review Tool. Event orientated)

The Pert method of network analysis was developed by the U.S. Navy S.P.O. in order to control the activities of the 250 main contractors and 9 000 sub-contractors involved in the "Polaris" submarine programme.

The problem facing the U.S. Navy was one of time and not cost. In other words the navy had to complete the Polaris Nuclear Submarine construction by a set and date (say 1 December 1963). The cost of achieving this end date by accelerating the constructional activities was of no importance compared to the final event or completion date. Pert is not cost related.

CPM (Critical Path Method – Activity Orientated)

CPM was developed with a production/construction application in mind. It is basically a method of determining the best time/cost relationship. The construction period required for building 100 houses could be either 30 months, 24 months or 18 months. The cost of reducing a contract period from 30 months to 24 months may be more than compensated for the extra savings, making it a viable proposition.

The cost of reducing the same contract to 18 months may not be viable because the costs are now exceeding the savings.

CPM is basically a programming method where the time/cost relationship of the various construction activities is balanced to achieve maximum profitability and more suitable to the building industry than PERT.

Various other methods have been developed and these included: CPPS, RAMPS, PEP, CPS, SCAWS, SPERT and the most recent development is the Precedance Network.

In practice one finds that the programming technique adopted by any building firm is a combination of a few of the above-mentioned methods.

A.o.N NETWORK PROGRAMMING

We have seen how one can generate a programme for a building project using the bar chart technique. The disadvantage of this method is that it does not allow us to show relationships between activities which one needs when executing building works.

These relationships have to be considered and are necessary; for example, one cannot lay the roof tiles if the trusses are not in position. On a bar chart it could be very misleading and may show that it is possible when in reality it is not.

THE SYMBOLS

This is called a node and it denotes an activity of work to be done e.g. foundation brickwork or surface beds.

_____ Shows the relationship between the activities

EXERCISES

1. Sketch the following nine 'phases' in AoA and AoN format. Since they form parts of completed networks, they are not necessarily complete in themselves, that is, they do not start from, nor do they finish on, a single event.

   (i) Task K depends on tasks A and B.
   (ii) Task K and task L depend on tasks A and B.
   (iii) Task K depends on tasks A and B and task L depends only on task B.
   (iv) Task K depends only on task A, but task L depends on both tasks A and B.
   (v) Task K depends on tasks A and C, and task L depends on tasks B and C.
   (vi) Task K depends on tasks A and C, task L depends on tasks B and C and task M depends only on task C.
   (vii) Task K depends on task A, task L depends on task B, and task M depends on tasks A, B and C.
   (viii) Task K depends on task A, task L depends on tasks A and B, and task M depends on tasks B and C.
   (ix) Task K depends on task A, task L depends on tasks A and B, and task M depends on tasks A, B and C.

SCHEDULING AND CALCULATION OF FLOAT IN AoN NETWORKS

Various conventions are used on the node such as:

Below is a typical activity on node diagram analysed.

E.S. = highest preceding E.S. +d.
L.F. = lowest of succeeding L.F. – d
E.F. = E.S. +d of same activity
L.S. = L.F. – d of same activity.

Examine the examples below:

1. Calculate the earliest activity times by working through the diagram and selecting the longest path

   In order that the diagram can start and end with a single activity, START and FINISH nodes have been introduced at the beginning and at the end.

   The earliest start time of an activity is the highest earliest finish of preceding activities. The earliest finish time is earliest start + duration.

2. Calculate the latest activity times by working backwards through the diagram again selecting the longest path

   The latest finish time is the latest time by which the activity can be completed without affecting the project duration. The latest time for the end activity is therefore the same as the earliest finish time.

   The latest finish time for other activities is the lowest latest start time of their succeeding activities. The latest start time = latest finish – duration.

3. Critical activities

   For critical activities, the earliest and latest times are the same.

4. Float

   Total float
   Latest start time – earliest start time.

or
Latest finish time – earliest finish time.

Free float
Free float activity x = lowest earliest start of succeeding activities – earliest finish of activity x.

Interfering float
Total float – free float.

Independent float
Independent float on activity x = lowest earliest start of succeeding activities – highest latest finish of preceding activities – duration of activity x.

EXERCISE

Draw an AoN network represent by:

	Activity	Precedes	Duration
START	A	D,E	4
	B	F,G	6
	C	G	2
	D	L	3
	E	H	8
	F	H,K	9
	G	L	10
	H	L	6
	K	L	8
FINISH	L	-	1

Analyze this network and draw a bar chart.

PLANNING

Planning is the investigation and forecasting of future events.

Before a building company submits its Tender Price it must PLAN the future contract so that the most efficient and economic use of labour and materials is considered. Any contract which is planned efficiently at Pre-Tender stage will be priced competitively with a good tender success rate.

OBJECTIVES OF PLANNING

(a) to show the quickest and cheapest method of carrying out the work consistent with the available resources of the builder;

(b) to ensure by the proper phasing of operation with balanced labour gangs in all trades continuous productive work for all the operatives employed and to reduce unproductive time to a minimum;

(c) to provide an assessment of the level of productivity in all trades so as to permit the establishment of equitable bonus targets;

(d) to determine attendance dates and periods for all sub-contractors work;

(e) to provide information on material quantities and essential delivery dates, the quantity and capacity of the plant required and the periods it will be on site;

(f) to provide, at any time during the contract, a simple and rapid method of measuring progress, for the builder's information, the architect's periodical certificate or the valuation of work for accounting purposes.

In any successful contract there are 3 kinds of Planning:

1. PRE-TENDER PLANNING
2. PRE-CONTRACT PLANNING
3. CONTRACT PLANNING

Let us consider Pre-Tender Planning which is the planning a construction company does prior to tender opening.

A minimum of 21 days is allowed by the MBA between the tender advertisement and the tender opening.

In an economic climate where work is scarce and profit margin is low it is essential that the contractor submits an accurate tender figure. The accuracy of this tender figure depends on the amount of planning and investigating of conditions the contractor performs prior to submitting his tender figure.

1.1 Objective of Pre-Tender Planning

The objective of Pre-Tender Planning is to reduce, or eliminate, the risk of inaccurate opinions influencing decisions which affect the pricing of the TENDER. By harnessing the resources and experiences of the company to guide the Estimator when he is considering items of risk, or more difficult structural problems, he is better enabled to calculate a more realistic and accurate assessment for the work involved.

1.2 Steps in Pre-Tender Planning

(1) Decision to tender
(2) Pre-tender meeting
(3) Site visit report
(4) Enquiries to sub-contractors and suppliers
(5) Method statements
(6) Build-up of estimate
(7) Pre-tender programme
(8) Build-up of contract preliminaries
(9) Adjudication of estimate
(10) Analysis of tender performance

1.2.1 Decision to render

Consideration must be given to the following factors that may have an effect on the decision to tender.

(a) Site Conditions
It is recommendable to consider site conditions before the decision to tender is taken. These conditions must be reflected in the site visit report.

See handbook (Cooke, B: Contract Planning and Contractual Procedures) item 2.3 on pages 17-20 for the purpose of and the information that must be reflected on a site report. See also page 6 of these notes.

(b) Technological Factors
- (i) Accuracy required and tolerances allowed.
- (ii) Constructional difficulties.
- (iii) Similarity to previous projects.
- (iv) "First time" technology, e.g. Koeberg Power Station that may involve new or unknown construction methods.
- (v) Departure from present type, nature and scope of projects handled.

(c) Contractual Factors
- (i) Previous knowledge of other parties (consultants, suppliers, etc).
- (ii) Own work in relation to nominated sub-contractors.
- (iii) Terms and conditions of contract.

(iv) Retention limits.
(v) Defects limits.
(vi) Provision of surety.
(vii) Insurance.
(viii) Type of contract.
(ix) Provision for escalation.
(x) Risk involved. Etc.
(xi) Time for completion (take into account time/cost trade/off).

(d) Legal Factors
(i) Local authority regulations.
(ii) Acts building in specific area.
(iii) Industrial Council agreements in area.

(e) Economical Factors
(i) Period in business cycle, i.e. "boom" or "recession" that determines the availability of contracts.
(ii) Interest rates on borrowed capital
(iii) Availability of finance for capital outlay and/or expansion.
(iv) Number of competitors.

(f) Financial Factors
(i) Capital available in reserve funds and obtainable from other institutions or share holders.
(ii) Value of new project in relations to those handled to date.
(iii) Effect of capital commitment on present projects.
(iv) Project that can be realised.
(v) Rate of return on investment.
(vi) How many times is it anticipated that capital will be turned over during the financial year?

(g) Resource Factors

Consideration must be given to the resources required on the project in question and in comparison with the resources available and occupied at the time involved. This goes for staff, labour, plant, materials and sub-contractors.

Consideration must also be given to the availability of these resources in the area concerned, and if not, the transport involved in getting it to the site.

If all available staff is occupied at the time, it is obvious that recruiting will have to be done in order to carry out the work.

Accommodation and office facilities for staff and labour must be considered.

(h) Public Relations Factors
(i) Advertisement to Co. e.g. Van Stadens bridge, Carlton Centre, Mount Road Police Station, etc.

(ii) Future job possibilities with the client.

(j) Political Factors
(i) Trade union influence with regard to unrest, strikes, etc.
(ii) Effect of government spending policy i.e. funds allocated to certain growth points; development of townships; low-income housing, etc.

See also the checklist in Cooke, pages 10 and 11 that list the information.

(a) to enable a decision, and
(b) additional information that should be taken into account by management.

1.3 Pre-Tender Meeting

Once the decision to tender has been made by top management a Pre-tender meeting must be held, the purpose of which is to plan and phase the activities of the Pre-tender planning phase. The responsibilities of the various personnel are identified. The personnel required at the meeting include:

MD – Chairman of meeting
Chief Estimator
Contracts Manager
Planning Engineer
Chief Buyer
Office Manager
Job Estimator

Depending on the size of the company one man may have several functions. In a small firm the MD may also do the Planning and Estimating.

Main items to be considered at meeting

(1) The Chairman will decide how badly the firm needs the contract. This degree of interest can be discussed under the following categories:

Category A: Full Treatment – Anxious to obtain, submit a teen tender, i.e. low profit.

Category B: Detailed Treatment – Prepared invest reasonable estimating effort to gain work. Reasonable profit less chance of obtaining the contract.

Category C: Routine Treatment – Do not need the contract and a high profit margin is allowed for. If the contractor is successful he considers it a 'bonus'.

Category D: Minimum Treatment – Submits a 'cover price' in order to be on the list of tenders received.

Responsibilities of Personnel involved in Tender Preparation

(1) General Manager/Director
- (i) to act as chairman at the initial and main tender meeting and brief personnel on their duties during the estimate preparation;
- (ii) to ensure that scheduled dates as set out in the pre-tender check list are seen to be achievable and are recognised by those concerned;
- (iii) to be alive to general market conditions and current events which may be influence the tender;
- (iv) to adjudicate the estimate on its completion, assisted by senior management.

(2) Chief Estimator
To control and monitor the collection of tender information and feed the data to the job estimator. To guide and check the estimator's work throughout the tender preparation. To assist in adjudication and to ensure that all consequent adjustment are checked.

(3) Contracts Manager
To assist the job estimator in the preparation of the site visit report. To prepare the statement of construction methods indicating the plant requirements to be included in the preliminaries. The contracts manager will also give advice to the planning engineer regarding the preparation of the pre-tender programme.

The contracts manager must consider his on-site labour requirements.

(4) Planning Engineer
To prepare the pre-contract programme assisted by the contracts manager. An accurate assessment of the contract period is necessary as this is the time period on which resource allocations and the contract preliminaries will be based.

Where the contract period is specified in the contract documents, its feasibility should be checked. There are key areas on most sites where congestion of activities may occur and a detailed planning exercise may be required.

(5) Buyer
Firms vary widely in their purchasing procedures. Some highly organised buying departments do not participate in estimating but afford a service, once a contract is won and the documents are received, which includes scheduling, progress chasing, works inspection and many other services. Other firms have a buyer who undertakes tender enquiries and places covering orders when contracts are won, but leaves the scheduling and call up of materials to site staff.

The buyer is normally responsible for preparing the enquiries to material suppliers and sub-contractors at estimate stage. The enquiries must be sent out as early as possible in the estimate period to enable the firms to return the enquiries. The buyer will be responsible for comparing quotations received and passing the information to the job estimator for inclusion in the estimate build-up.

(6) Office Manager

Responsible for co-ordinating the tender information. Documentation produced throughout the tender will require collating for the tender adjudication meeting.

Quotations will be required for insurances and the provision of a contract bond where applicable. The assessment of the overhead percentage for the head office may also be the office manager's responsibility in conjunction with the accountant director.

(7) Job Estimator

Responsible for the build-up in net form of the rates for inclusion in the priced bill. The labour, plant and materials analysis of each rate may be indicated in order to assist analysis at the adjudication stage.

The job estimator will obtain materials quotations and may be advised by the chief estimator as to the responsibility of both these and the sub-contractors' quotations, bearing in mind the experience of the firm concerned.

Labour constants are the means by which provision is made for the allowance for the work element, usually in the form of a factor applied to the billed quantity.

1.4 Site Visit Report

All contractors tendering on a job are invited to the Site Visit where at a certain date (usually 2 weeks prior to tender opening) the architect/engineer takes the contractor for a tour of the proposed site and answers any relevant questions regarding soil conditions, availability of water, electricity, etc. The contractor's representative (usually contracts manager) must evaluate the site and consider any site restraints or factors which will have a financial on the contract.

The following report is compiled:

List all the relevant information under the following headings:

16. Expecting capability
17. Previous experiences that you and other contractors have had him (the sub-contractor)

These factors will influence the contractor's decision on which sub-contractors to ask for quotations from and once received which sub-contractor to choose if the contract is awarded to the contractor.

B. Suppliers

- Previous experiences your Company, and other have had with supplier
- Strength and stability of his business
- Experience as a supplier in his field of business
- How realistic his quotations are
- Quality of his materials
- Consistent standards of his materials
- How and where he gets his supplies from (buy in or self manufacturer)
- Quantity discounts; cash discounts
- Does he undertake to deliver?
- Reputation
- Reserve facilities
- Location in relation to construction site
- Internal facilities of supplier (well equipped; condition of stores, etc)
- Labour relations (Any unrests: etc. – Labour policies and practices)
- Single or multiple supplier
- After sales service
- Credit facilities

If the contractor is successful with his tender he should order the materials through the supplier that he has obtained quotes from. A contractor who 'shops around' after receiving quotes may find in the future that his suppliers do not give him competitive prices and he may lose contracts as a result.

1.6 Method Statements

The method statement mainly deals with the method whereby the work will be executed but it is just as important for programming pricing (prices are based on the method and durations) and the determination of plant requirements and the determination of plant requirements and the determination of labour requirements. The production team must be given the opportunity at this point to have an input in the planning of the construction.

A method statement analysis the various methods available to the contractor to perform an item of work i.e. excavate trenches or pour concrete suspended floors.

SITE VISIT REPORT	
TENDER NO.	**PREPARED BY:**
CONTRACT	
DATE	

INFORMATION AVAILABLE

1. LOCATION OF SITE
2. TRANSPORT SERVICES TO SITE
3. ADDRESS OF JOB CENTRE
4. OTHER CONTRACTS IN AREA
5. ACCESS TO SITE
6. GROUND CONDITIONS ON SITE
   TOPOGRAPHY
   SURFACE WATER CONDITIONS
7. DETAILS OF TRIAL PITS AND WATER TABLE LEVELS
8. EXTENT OF SITE FENCING
9. SITE SECURITY AND LIGHTING
10. AVAILABILITY OF SUB-CONTRACTORS
11. EXTENT OF WELFARE FACILITIES REQUIRED
12. TEMPORARY SERVICES TO BE PROVIDED
13. ANY SPECIAL REQUIREMENTS

1.5 Enquiries to Sub-Contractors and Suppliers

A. Sub-Contractors

1. No. of trade enquiries – competition
2. Policy of sharing – good relations
3. Dates of sub-contractors
4. Compliance with Bill of Quantities and specifications
5. Consistency of unit rates throughout quotation
6. Rates realistic in relation to that of competitors
7. Preliminaries and attendances included?
8. Compliance with main contract (payment per: ret: def. liab.)
9. Onerous (burdensome) conditions
10. Quality and extent of supervision
11. Competence and mastery of speciality
12. Degree to which dependent on further sub-contracting
13. Availability and condition of equipment
14. Economic and financial stability
15. Labour policies and practices

The contractor must compare the various methods and choose the method most suitable for the task based on its cost vs. time relationship.

METHOD STATEMENT							
CONTRACT: TENDER NO.:							
Operation No.	Operation	Quantity	Method	Sequence of Operations	Plant & Labour	Output	Labour

EXAMPLE ON THE PREPARATION OF METHOD STATEMENTS
Example for Siteworks Project – City Site.

Contract Information

Reduced level excavation is to be carried out for a housing project. The area of the site on plan is 200m by 150m and an average excavation depth of 0.50m is to be carried off the site to a nearby tip.

Assumptions based on site visit report

(1) Good access to site by means of existing streets which should be left in position until the excavation work is complete.
(2) Local authority tipping facilities located 3km from the site. Tipping fee R300.00 per load.
(3) Surface material to be excavated consists of filling material remaining from demolished properties. A number of cellars are apparent on the block plans for the site. The existing site is reasonably level.

Method considerations

Method 1. Use a crawler tractor, hydraulic power shovel with a $1.5m^3$ capacity bucket. A number of machines are to be used loading 8 to $10m^3$ capacity tipping trucks.

Alternative Methods

Method 2. Use a tracked hydraulic excavator fitted with back-actor arm. Excavator fitted with wide $1m^3$ capacity bucket. Excavator to load trucks direct.

Method 3. Use of D6 bulldozer to excavate and push the material into spoil heaps adjacent to the access roads. Excavate using draglines located on top of spoil heaps and load tipping trucks direct. Two draglines to be utilised.

Class Exercise

Draw up a Method Statement for the following activity

Excavate a trench 500mm wide with an average depth of 2,5m in soft material.
A 400mm pipe is to be a laid in 2,5m sections.
The trench is then backfilled using the excavated material.
Spoil material is to be ridden away.
Trench is 500m long.

1.6 Build up of estimate

Once the previous 5 steps have been completed the net estimate bill rates build up from labour, material and plant can be compiled and analysed in columns adjacent to the bill items.

	REINFORCED BRICKWORK IN LINTOLS IN 1:3 CEMENT MORTAR (REINFORCEMENT ELSEWHERE MEASURED)			
12	Half brick wall	m^2	2	
13	Once brick wall	m^2	3	
14	270mm Hollow wall formed of two half brick thicknesses with cavity between, including ties These net rates do not include P ÷ G's Overheads or Profits	m^2	13	

1.7 Pre-Tender Programme

The estimator cannot work in isolation in determining the estimated cost for a project. The estimate must be done in conjunction with the methods that will be followed, (method statement) resources applied and the duration complete to the activities. He must therefore work in conjunction with the planning department (if available) and base his estimate on their programme. This programme will normally start off in the form of a network and be presented in the form of a bar chart. Pre-tender planning can be seen as consisting overall of:

(i) Preparation of an estimate, and
(ii) Preparation of a programme.

It is always advisable to discuss the preparation of the programme with the construction staff since they are the men who will eventually have to do the work and they may well wish to influence some of the methods.

One of the first steps in formulating a programme is to decide, in broad outline, the manner in which the job is to be tackled. Items which have to be considered are:

(i) The point at which construction will start and the general flow of work, i.e. from north to south or south to north.
(ii) The items of major plant and their location on the site and whether they will have to be moved during the construction period.
(iii) Methods for the bulk items of work.
(iv) Access to the site.
(v) Movement on the site

At the Pre-Tender stage the programme is usually rough with no intricate details and shows expected start and completion dates of major activities duration for large plant on site (i.e. cranes, mixers, etc)

The contract duration is usually stipulated in the conditions of contract and it is to this maximum time limit that the contractor programmes his contract duration.

With the high cost of finance and rampant escalation it is critical for the developer that the contractor does not run over his contract period. With this in mind most contracts have substantial penalty and bonus clauses for overdue and early completion of contracts.

The contractor may also submit an alternative (usually lower) time period with an alternative price. It may be in the best interests of the client to accept this reduced contract period.

1.8 Build-up of preliminaries

The preliminaries (P+G) section of a Bill of Quantities must now be priced. The items which fall under the P+G's are usually time related items dealing with site overheads.

They are claimed by the contractor on a pro-rata time basis.

The preliminary items which are normally priced on a contract include:

(1) Site staffing
(2) Cleaning site and clearing rubbish
(3) Site transport services
(4) Mechanical plant and hoisting
(5) Scaffolding and gantries
(6) Site accommodation
(7) Small plant
(8) Temporary services and reinstatement
(9) Public Services – electric, gas, telephones, fees and rates
(10) Temporary water installations
(11) Welfare and safety provisions
(12) Final clearance and hand over
(13) Transport of men to site
(14) Setting out the works
(15) Samples and testing
(16) Attendance on sub-contractors and suppliers
(17) Insurances
(18) Fixed price allowance

The following preliminary items are affected by the location of the site:

(1) Travelling expenses for operatives
(2) Provision of site transport and vehicle for site manager's use
(3) Access problems associated with undertaking the works
(4) Temporary hardstandings for plant
(5) Extent of temporary access roads

These items where relevant must be priced when building up the contract preliminaries.

If the contractor loads his 'P+G' he may not win the contract or if successful the Q.S. may require him to trim his 'P+G'.

Overheads and Profits are added to the preliminaries along with Provisional Sums to arrive at the total preliminaries.

1.9 Adjudication of Estimate

Adjudication is Top Management's input to convert the 'estimate' into a 'tender'. The estimate is the 'Net Cost' of the contract and Top Management must

decide what Profit and Overhead mark-up to load the estimate with to arrive at the 'Tender Figure'. This mar-up will depend on the Category of the Contract (i.e. Category A, B, C or D).

It is also of vital importance that before Top Management applies the final mark-up all of the Pre-Tender information is reviewed for any market condition or policy changes.

1.10 Analysis of Tender Performance

This activity involves record-keeping and analysis of all tender results – whether won or lost. These records can be used to analyse whether alterations are necessary in profit mark-up, percentage overheads added, percentage preliminaries or in the tendering policy. This record must include all the parties that tendered and all the tender prices.

Documents to keep in Pre-Tender Planning

Consideration must be given to the preparation of the following documents:

(a) Tender summary of enquiry documents including a directory of the client and his professional advisers, a description of the works, a précis of the contract and any special clauses, and any other aspects of particular importance.

(b) Master file of correspondence, reports and notes of meetings or conversations.

(c) Site inspection report on site conditions, access, existing services and facilities, local position, any special circumstances, and a map or sketch of the area. For this purpose a standard check list is desirable.

(d) Outline programme of construction timing, probably plotted in months only.

(e) Methods statement noting any particular methods of construction or types of equipment.

(f) Organisation scheme including schedules of site personnel, accommodation, temporary works, extra labour allowance and any other site on-costs.

(g) Sub-contract tenders consider or used.

(h) Suppliers' quotations received for prices and delivery periods.

(i) Financial analysis of the provisional estimate, listing separately the calculated figures for preliminaries, on-costs, labour, plant and material costs, nominated sub-contractors and suppliers, provisional sums, domestic sub-contractors, overhead and anticipated profit.

SUMMARY

The objectives of Pre-Tender Planning

Some of the objectives of pre-tender planning are:

(a) To pool the company's past experience and the knowledge of its various departments and specialists;

(b) To eliminate controversy between estimator and supervisor on such matters as method, output rates, preliminaries and on-costs;

(c) To ensure a realistic tender by co-ordinating technical theory with current practice; and

(d) To improve the ratio of award (successful tenders) to tenders submitted, by reason of the increased attention to detail and advantages of co-operation.

The more homework a contractor does prior to the submission of his price the more chance he has of being the successful tenderer and having won the job, completing it with forecasted profit achieved.

2. PRE-CONTRACT PLANNING

After the tender is awarded and before the work on site a certain amount of planning is required by the Contracting team. This planning include the Estimator, Planner, Contracts Manager (in consultation with his site agents and foremen) and various other department heads such as the Plant Manager and Personnel Manager.

The aim of this planning is, amongst others, to set up systems (production, cost) whereby the activities and progress and the project can be monitored and consequently, controlled in order to reach the completion target.

The Joint Practice Committee (BIFSA) recommends a reasonable period for this purpose to allow the contractor to draw upon his resources, establish the site and make the necessary arrangements to start construction. A commencement date is normally stated in the contract schedule.

STAGES OF A BUILDING CONTRACT: INCORPORATING THE STANDARD FORM OF CONTRACT

MANAGEMENT ROLE IN PRE-CONTRACT PLANNING

2.1 PRE-CONTRACT INITIAL ARRANGEMENTS

(a) CONTACT OTHER PARTIES

Prior to commencing a contract, liaison will be necessary between the contractor, architect, statutory undertakings and local authority. Initial contact will have to be made with key material suppliers and own and nominated subcontractors (if known) together with plant hire firms likely to be participating in the early contract stages. Also let your own staff know the happy tidings (maybe have a party!).

It is important that the prospective site manager becomes involved in the pre-contract planning as soon as possible after the award of the contract. It is often the policy within large firms to appoint the site manager up to 4 weeks prior to a contract's commencement. This allows time for the site manager to familiarise himself with the bills of quantities and contract drawings and to participate in the preparation of the master programme. The site manager at this stage will organise the setting up of the site including the preparation of the site layout plan. The short term programme for the initial period of the contract may also be prepared together with finalising construction methods and plant requirements.

(b) PRE-CONTRACT PLANNING MEETING

A meeting will be held to announce the award of the contract and to acquaint all concerned with the general background information. This will assist in developing close co-ordination between the estimating, surveying and contract management teams and in the development of a team spirit.

The chief estimator or a director will act as chairman for the meeting and he should be fully conversant with all decisions taken during the preparation of the tender. The meeting may be used by the company to pass over the tender documentation form the estimating to the contracts department.

The following personnel will normally attend the pre-contract planning meeting:

Chief Estimator

Responsible for

1. Acting as meeting chairperson

2. Handling over all tendering data to the respective personnel.
   e.g. Estimate summary and adjudication data
   Build-up of net bill rates

Summary of subcontractors' and suppliers' quotations
Method statements
Preliminaries build-up

Contracts Manager

Responsible for

1. Organising the commencement of work by the programmed date.

2. Appointment of site manager and/or arrangements for transfer of site management personnel.

3. Preparation or assistance in the preparation of the master programme in conjunction with the planning engineer and prospective site manager.

4. Finalising the statement of construction methods and schedule of plant and equipment requirements.

5. Preparation of the site layout plan.

6. Preparation of expenditure budgets for labour, plant and preliminaries.

Buyer

Responsible for

1. Finalising quotations with suppliers and subcontractors.

2. Preparing schedules including co-ordinating material requirements with the master programme.

3. Placing orders with material suppliers and own and nominated subcontractors. In certain organisations it may be considered a quantity surveying function to place subcontractors' orders.

4. Preparing schedules of key dates for the delivery of materials.

Chief Quantity Surveyor

Responsible for

1. Checking and arranging for the signing of the contract documents.

2. Appointment of surveying staff for the contract.

3. Preparation of the contract valuation forecast and cost flow assessment.

4. Distribution of copies of the bills of quantities.

5. Preparation of forms of contract for own and nominated subcontracts in conjunction with the buying department.

Office Manager

Responsible for

1. Preparation of master files for the contract.

2. Distribution of all letters in relation to the contract (general office to act as central clearing house for contract mail).

3. Appointment of clerical staff for the contract to assist with the site administration.

4. Arrangement of insurance.

5. Serving of notices and payment of fees.

6. Arrangement for office stationery and safety packs to be despatched to site.

Chief Planning Engineer

Responsible for

1. Preparation of master programme for the contract. This will involve a review of the tender programme and current drawings available. Liaison with the contracts manager or site manager regarding the sequence of work, key dates and labour resourcing.

(c) REGISTRATION OF DRAWINGS

It is of importance to the contractor that records are kept of the receipt of all contract information as at some later stage contractual claims may arise. From the initial stage a drawing register must be kept to record the issue date of drawings received from the architect and other consultants.

(d) MAKE ARRANGEMENTS TO COMMENCE WORK

1. The Preparation of the Site Layout Plan

This enables the site manager to consider access problems, the positioning of offices, site accommodation location of plant, storage facilities etc.

2. **Temporary Site Services**

Applications must be made for all temporary services requirements during the pre-contract period, e.g. water, electricity and telephone services.

3. **Licences, Permits and Notices**

Licences are required for hoardings, gantries over a public right of way and for the storage of petrol or explosives on site. Permits are required for road closures, part road closures, catering facilities on site and overtime working.

4. **Small Tools and Equipment Requirements**

Many of the larger firms provide small tools and equipment from the head office stores at the commencement of a contract. A small tools requisition schedule is completed by the site manager for delivery to site during the early stages of the contract. This enables the head office to take advantage of bulk purchases on small tools.

2.2 DRAWING UP OF ORGANISATION STRUCTURE

A project organisational structure is drawn up indicating positions, responsibilities, interrelationships and lines of communication between site personnel.

This organogram is essential

(i) To ensure that each person known his/her responsibilities, duties, powers, etc. in relation to the others and

(ii) To ensure an even flow of communication in the issue of orders, reporting and feedback.

A proper organogram will indicate position (posts; designations); provide a list of duties and responsibilities (job description); indicate the interrelationships and the lines of communication.

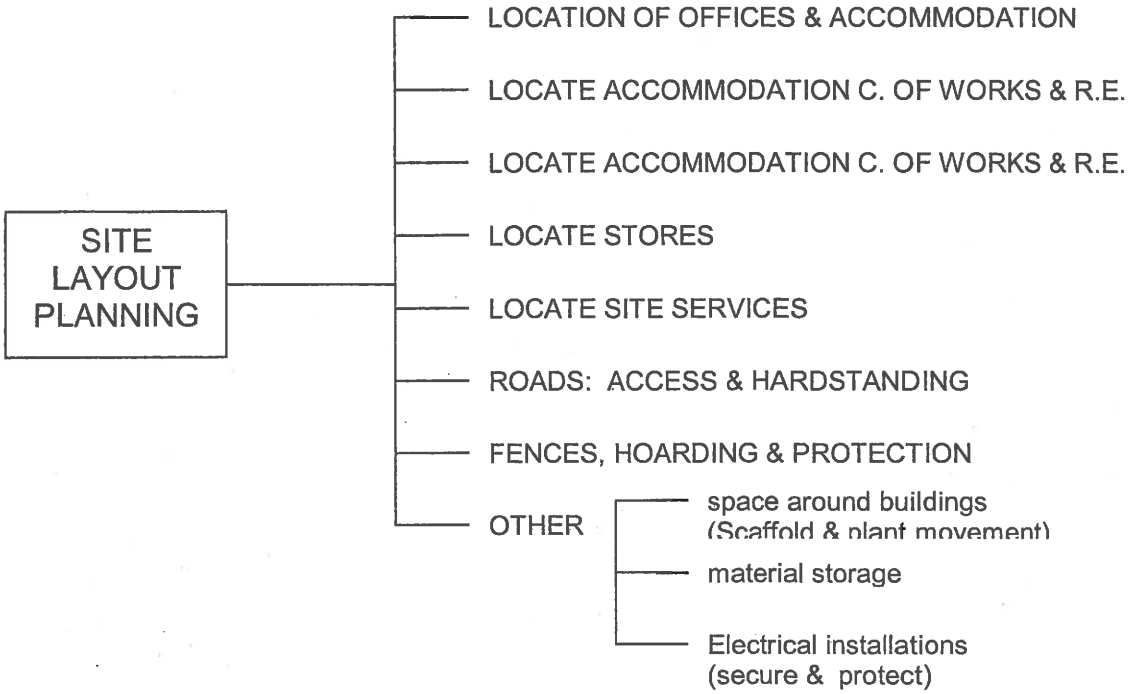
Care must be taken

(i) not to have too wide a span – to ensure that the responsibility that the top person holds, can be carried out;

(ii) not to have too many levels that causes communication losses and;

(iii) not to duplicate functions.

2.3 PLANNING A SITE LAYOUT



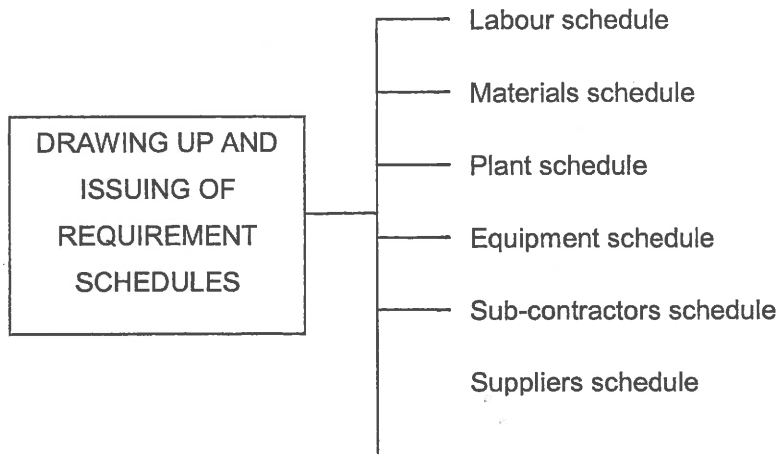
The site layout must now be planned using a drawing with a relevant information drawn on it (as per Chapter 1).

2.4 PLACE ORDERS WITH SUB-CONTRACTOR AND SUPPLIERS

Orders must now be placed with the sub-contractor and suppliers whom quotes were obtained from during the Pre-Tender Planning Phase. Usually the lowest price (one used in the Tender Price) is accepted.

A programme should be issued to ensure the subbies/suppliers can master their resources and be able to start work or deliver materials as and when required.

2.5 DRAW UP REQUIREMENT SCHEDULES



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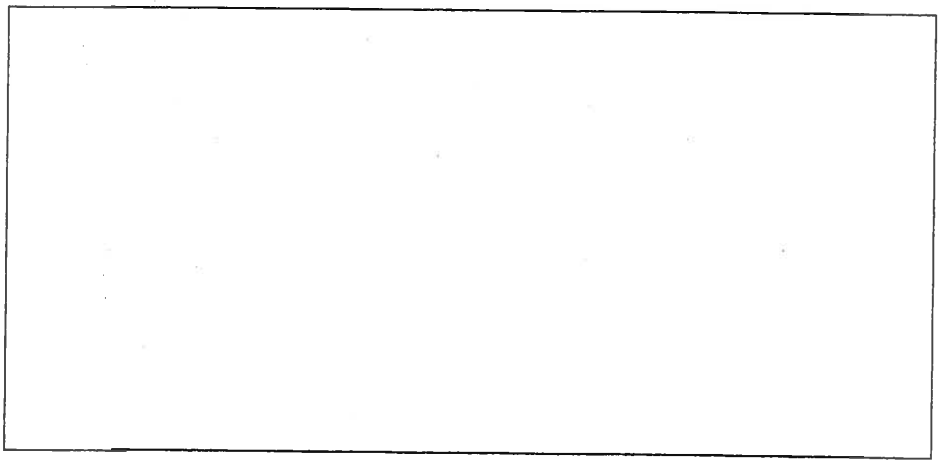
—— Information schedule

(a) LABOUR REQUIREMENT SCHEDULE

This schedule usually takes the form of a labour histogram based on the contract program, i.e.

Activity	Day														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10-20	6	6	6												
10-20	2	2	2	2											
10-40	4	4													
20-40				3	3	3	3								
20-50				5	5										
30-40					3										
40-50								4	4	4					
40-50								5	5	5					
50-50											2	2	2	2	
50-70															5
Total	12	12	8	10	11	3	3	10	10	10	2	2	2	2	5



(b) **MATERIALS SCHEDULE** is now drawn up the contracts manager working in conjunction with the planner and the estimator.

Materials with a long delivery time must be paid special attention and any discrepancies between the Spec, B.O.Q. and drawings must now be ironed out (if possible).

MATERIALS SCHEDULE											
CONTRACT										**SHEET NO.**	
DATE										**PREPARED BY:**	
								Key Dates			
	Material Description	Supplier	Address/ Tel.No.	Order No.	Quantity	Bill Ref.	Date Ordered	Notice Reqd.	Date Reqd.	Date Read	Remarks

(c) PLANT SCHEDULE

The plant requirements for the project must be finalised after a review of the method statement and consideration of the plant allocated in the contract preliminaries. Methods of construction at this stage may be revised, provided they do not involve any additional expense and fall within the estimated cost.

Plant requirements must be phased in to suit the order and sequence of the master programme. A separate plant schedule may be indicated in bar chart form to show the key dates for the commencement and completion of major operations involving plant utilisation.

(d) EQUIPMENT SCHEDULE

A small tools and equipment schedule may be drawn up in order to allow the yard to transfer or buy new tools as required.

(e) SUB-CONTRACTOR SCHEDULE

The co-ordination of sub-contractors and nominated suppliers into the contract planning is an essential requirement for the contractor. The schedule indicated below provides a summary of the major sub-contractors and suppliers and highlights the notice required, bill reference and planned and actual commencement and completion dates.

The key sub-contractors' commencement dates will also be indicated on the master programme. A separate sub-contractor's programme may also be prepared in order to match related operations.

(f) INFORMATION SCHEDULE FROM DESIGN TEAM

The architect must ensure that full contract information is available to the contractor to meet the requirements of the master programme. This information requirement schedule below enables the contractor to request information from the architect in advance of the anticipated commencement date of an operation on site. This may be used for calling forward information of the following type:

1. Setting out drawings and the conformation of key dimension.
2. Foundation details, bolt positions, pockets and holes for services.
3. Details of steel reinforcement bending schedules from the consulting engineer.
4. Colour, decoration and finishing schedules.
5. Services layout drawings.

6. Latest dates for nomination.
7. P.C. amounts.

2.6 DRAW UP MASTER AND SECTION PROGRAMS

A master programme must be drawn up using the Pre-Tender programme as a base from which to develop.

Most contract programmes take the form of a bar chart based on a "Network Calculation". A master program covers the entire contract period from site handover to Practical Completion. The main purpose of the master programme is to outline the building procedures and contract time requirements.

SECTION PROGRAMME

Critical areas of the Master Programme are isolated and expanded into separate "Section Programmes" which indicate the sequence and timing of events in much greater detail.

2.7 DRAWINGS OF BUDGETS AND BUDGETARY CONTROLS AND CASH FLOW

A budget is a forecast or, plan against which to monitor performance.

The most important budget a construction company will be involved with is a "cash flow budget" which monitors the amount of cash being earned on a contract as apposed to the amount of cash being spent. This cash flow takes into account factors such as payment periods, retention etc.

3. CONTRACT PLANNING

After a contractor has been awarded a contract the actual construction planning phase begins. If the contractor has been thorough during the pre-tender planning stage his task is now much easier.

Construction or Project planning is performed by a central planning department (if the contractor is large enough) in conjunction with the contracts manager, site supervisor and/or site foreman. This is to ensure that when the programme arrives on site the site personnel have had a meaningful input and are likely to adhere to the programme.

Overall planning of the project is performed prior to construction to allow management and site personnel to familiarise themselves with the construction techniques and problems etc. There are three distinct phases to contract planning:

1. Contract Assessment
2. Programming of Construction Activities

3. Co-ordination of relevant parties

3.1 CONTRACT ASSESSMENT

(a) NOTIFICATION OF STAFF

When a contract has been awarded it is good for the morale of the employees and contract details should be circulated within the firm. These details should include, description, value, client, address, architect and contract duration.

(b) PLANNING MEETING

A Planning Meeting must be held which involves the senior manager, estimator, buyer plant management, planner and site personnel. All the information must be further developed with additional information and brought up to date.

(c) CONTRACT DOCUMENTS

The contract documents must be scrutinized and these may include:

1. **Drawings**

   A drawing register must be started, recording all drawings received up to date. All drawings must be carefully checked for mistakes. A note should be made of drawings required from the design team showing content and date required.

2. **Conditions of Contract**

   Provide specific information regarding the contract i.e. and completion dates, retention periods, partial occupation, guarantees etc.

3. **Specifications**

   Provide information regarding quality of workmanship and materials, construction techniques and constraints. The contractor must ensure that the specifications tie in with the information on the drawings and the Bill of Quantities.

4. **Bill of Quantities**

   Must be studied until the management and site team have familiarised themselves with the different items. P.C. amounts, Provisional Sums, Std. Preliminaries etc. Although a bill of Quantities is <u>never</u> to be used for ordering material it is a good check on whether quantities taken of drawings are correct. The contractor must check that there

are no discrepancies between the B.O.Q., the Specification and the Drawings.

3.2 PROGRAMMING OF CONSTRUCTION ACTIVTIES

The purpose of programmes have already been discussed and must be reviewed by yourselves.

It is important that every building activity be it of a direct operational nature i.e. Brickwork or a management activity i.e. Nominate Electrical Sub-Contractor be investigated and programmed in the most ordered and rational way.

In order to record the actual progress on site against the expected progress, a form of physical measurement has to be assumed i.e. quantities by volume, area, weight, length or number.

Example

200 m^2 of ceiling has to be skinned per day. If an average of only 170 m^2 of ceiling is skinned per day the contractor is lagging behind programme in that activity which may effect his entire completion date.

There are two basic types of programs:

1. Master programme
2. Section programme

These types of programs have already been discussed and must be revised by yourselves.

Programming will also enable the plant requirement to be forecasted and decisions can be reached at an early stage whether the plant is to be bought, hired or leased.

3.3 CO-ORDINATION OF RELEVANT PARTIES

A building contract is basically a team effort and without co-operation from all the team members and the correct co-ordination of the team members, no contract could be brought to a satisfactory completion.

The team members include:

1. Contractor
2. Design team
3. Nominated Sub-Contractor
4. Own Sub-Contractor
5. Suppliers
6. Nominated Suppliers
7. Local bodies i.e. Industrial Council, BIFSA
8. Municipal departments i.e. City Engineers Department

It is essential to co-ordinate these team members to ensure that information is available when required, progress payments are honoured, materials of he correct quantity and quality are delivered on site at the right place, sub-contracts start and finish at the correct times, site establishment facilities are sufficient and no building regulations are transgressed.

In order to liaise effectively, monthly site meetings are held with all relevant parties attending, with the architect acting as chairman. This is a formal meeting and minutes are taken and typed records are later distributed. The contractor may decide to hold his own sub-contract/supplier site meeting on a more regular basis.

Planning is a continuous process and during the construction period it may be necessary for the contractor to up-date his programme due to delays or extra work received from the client.

It is good practice for the site supervision staff to program the site on a weekly basis. The site agent in conjunction with the foreman draws up a programme for the following week detailing exactly what construction activities must occur in the following week and what production outputs are required. In this way any possible delays for materials, labour or plant can be picked up early, and progress can be monitored very closely.

CONCLUSION

Proper contract planning has a very direct and important influence on operational and overhead costs and helps to eliminate non-productive time, delays and communication problems. The success of planning does not only depend on the techniques used by also the willingness of the parties involved to use that planning to derive its maximum benefits.

TYPICAL QUESTIONS ON PLANNING

1. List the objectives of Planning. (5)

2. List 10 factors which may influence the builder's decision to tender. (10)

3. Discuss the differences between a Class A, B + C contract. (6)

4. Summarise the factors which will influence the contractor's prices when compiling his estimate. (10)

5. List the four major contract documents and briefly discuss them. (4)

6. List the 8 team members which must be co-ordinated to ensure a successful contract. (4)

TOTAL 39

3.4

3.2

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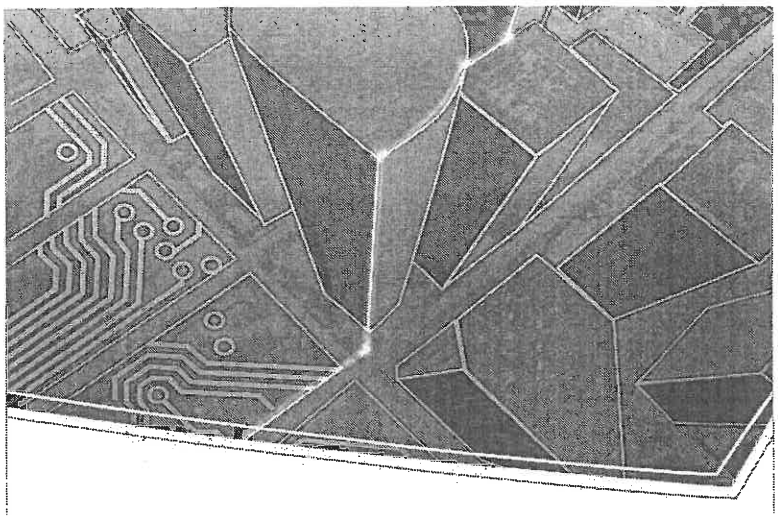
Construction Management III

Module 2 – Site Administration and Site Planning



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OBJECTIVES OF CHAPTER

1. After studying the notes and working through the given examples the student must be able to:

   - list the records kept on site
   - summarise the type of storage facilities required on site by writing a paragraph on each one
   - state how he would site static and mobile plant
   - summarize the advantages and disadvantages of the different types of sub-contractors.

2. Having worked our examples of estimating rates and calculating variances the student must summarise the reasons for variances by means of an example based on changes in labour and material costs and wastage.

Bibliography

Construction Site Procedures: Dawies

CHAPTER

SITE ADMINISTRATION AND PLANING

SITE ADMINISTRATION

The first contact a prospective builder has with a future site is the Pre-Tender visit. If the contractors tender is successful and he is awarded the contract a date will be set whereby the actual site will be handed over to the contractor by the architect. On the specified day and time the contractor, usually represented by the contracts manager and the site agent/supervisor, will meet the architect and the consulting engineer on site and the boundary pegs with the relevant datum levels will be indicated to the contractor. Once the site has been formally handed over the contract construction period begins. The contractors first duty is to check that the boundary pegs and datum levels as shown by the engineer is in fact correct. If the contractor does not query their validity with the architect within 7 days they will be taken as correct with all the responsibilities of correct setting out etc. resting on the contractor.

Once the site has been successfully handed over it is up to the contractor to plan his site layout. This site layout can be summarised under the following headings:

(i) ACCESS AND TRAFFIC ROUTES

Needs vary with the type of project and the stage of the job, but access from the main road should be duplicated where possible, with short direct routes and one-way traffic to encourage 'flow'. Alternative access by rail or canal can be used for bulk deliveries or lengthy components. Short term approaches may be constructed of hardcore, sleepers, concrete, proprietary track or transportable mats for mechanical navvies, but wherever possible, advantage should be taken of any permanent works for siting temporary roads or hardstandings. Ramps or bridges of interchangeable Bailey units or special fabrications may be necessary, while adequate drainage and maintenance of road surfaces is essential. Similarly, routes to spoil tips must be frequently repaired and attended; cross-overs must be provided for tracked vehicle negotiating metalled roads; and excavated material must be regularly cleared from adjacent highways. Traffic routes may be treated as clearways, or deliberately spanned by cranes for offloading purposes, and, on extensive sites, vehicle check points may be necessary for security reasons.

Permission must be obtained from the local authority for access over, or encroachment on public footpaths, and the police must be notified if roads are to be closed or diverted. The erection of fences or hoardings may be required, watching are lighting supplied, rights of way kept open, pedestrian walkways installed or vehicles tracks provided over trenches.

(ii) MATERIALS STORAGE AND HANDLING

The object here is to minimise the wastage and losses arising from careless handling, bed storage or theft, and to reduce costs by obviating double handling or unnecessary movement. Stores and compounds must be provided for tools and equipment, plant spares, and breakable or attractive components or materials. Racks must be constructed for scaffolding and stillages built for oildrums, while storage areas must be designated for bulk items such as bricks. Special attention must be paid to materials like cement or hardboards which must be protected against moisture, and goods which require careful stacking to prevent deformation, e.g. metal windows and stove-enamelled panels. Newly completed buildings or rooms can often be utilised and it may be helpful to construct garages, etc., early in the programme for this specific purpose. A site plan should show not only the locations but sizes of stacks, dates required, planned routes for distribution and the eventual destinations. Methods study techniques such as string diagrams may be used to ensure optimum convenience. Tidiness earns the twin rewards of safety and convenience, by helping to eliminate accidents such as nails in the feet, and facilitating the sorting of 'cut and bent' reinforcement, etc.

Sub-contractors' needs must be remembered, and suitable space allotted for their huts and materials. Security must be considered, including locked buildings, adequate fences with gates, the careful location of checkers' huts, the installation of a weighbridge if warranted, procedures for stores receipts and issued, fire precautions and the employment of a night watchman, guard dog or visiting patrolman.

There is a need for three types of storage.

1. A secure store for valuable items which may be pilfered and therefore require strict control.
2. A weatherproof store for materials which may deteriorate due to the affects of weather.
3. Storage for materials in the open. Stocks must be adequate to maintain production schedules.

The storage of materials will require some control. Usually, a time-keeper doubles as a storeman and therefore some small provision for an office and issue counter may be needed. For control purposes this should be provided close to the site entrance but not if it leads to uneconomic activity due to the location.

The items to be placed in <u>secure storage</u> should be numbered. This will indicate the quality of items which will then be allocated shelf or bin space. Once the shelf space area is known, the size of the secure hut can be calculated.

Those materials requiring protection from the weather will include items such as cement, timber components and plasterboard. They may be placed in an open barn or in a locked full-sided shed. The access to such material must be adequate and enable a 'first in first out' policy to be practised. Should mechanised handling be used, then space must be provided for loading.

Materials to be stored in the open such as bricks, drainage goods and other materials may require a sheet covering. It should be determined whether the materials should be placed in a compound or stored on site at the place of work.

MATERIALS HANDLING

It is of the utmost importance that any material delivered to site is checked before it is offloaded and stored and used. This checking is usually done by the time clerk or storeman. On a small site the foreman may do the checking. The checking consists of:

(a) **A QUANTITY CHECK:** to ensure that the delivery note supplied by the driver of the delivery vehicle corresponds with the actual quantity of goods delivered. If the quantities correspond the delivery note is signed and one copy is kept by the contractor. The supplier then invoices the contractor based on the quantities signed for on the delivery note. It is up to the contractor to reconcile the delivery note with the invoice before payment is made to the supplier.

(b) **A QUALITY CHECK:** it is essential that the materials be checked for correct quality before use. If the quality is found to be inferior, i.e. badly chipped facebricks, then the contractor must contact the supplier immediately and arrange for credit and the delivery of correct material.

(c) **CORRECT ORDER CHECK:** the contractor must ensure that the material delivered are the same as have been ordered based on architect's drawings and specifications. If there is to be a long delay due to the unavailability of specified materials the contractor would be advised to approach the architect with the problem and possibly suggest an alternative material.

(iii) SITE ESTABLISHMENT AND STORAGE PLANNING

Before any site offices, toilets, etc., are erected it is essential that the site management structure is agreed with the number of persons requiring offices and the type of office required. Sub-contractors requirements must also be allowed for. The maximum number of labourers and artisans must also be established in order to calculate toilet and change room facilities.

This office establishment must take into account the relationships between various members of the management team.

In many building contracts the client will ask the contractor to provide a room in which to hold all site meetings etc. and an office for his representative.

The site agent/foreman's office must have safe, permanent access and must be maintained and kept in a sanitary condition.

The offices must be situated on site in a position where the management staff has a good view over the site. A compromise between the location of the offices and amount of noise, dust and smells must be established.

(iv) PLANT, WORKSHOPS AND SERVICES

The choice of major items of plant is of real consequence on most sites, including weighing the merits of such alternatives as central batching versus individual concrete mixers, and cranes compared with hoists. Cranes must be superimposed on the scale plan to ensure that the required reach is available, and drawn to scale on vertical sections to check that obstructions are cleared. The type of scaffold to be used must also be decided, and quantities calculated.

Workshops for joiners and fitters, etc., must be decided and located, balancing easy access and short routes to the scene of construction with the necessity to avoid congestion of the site. Existing services must be pin-pointed to obviate disruption, and the routes of new ones considered when sitting buildings and roads. The installation of temporary petrol pumps, electric power and telephone lines, water and compressed air mains, etc., requires negotiation with the relevant authority and co-ordination with the general scheme of work.

Availability of water pressure or electricity characteristics may affect the size and cycle of mixers, choice of drive, and number of hand tools that can be powered.

LOCATION OF PLANT

The sitting of static plant and the parking of mobile plant should be given careful consideration.

Static plant such as hoists or tower cranes should be sited so that maximum utilisation is achieved. The radius of the crane should be used to cover the maximum area of the site. The crane should have access to the major materials storage area, the vehicle unloading area and any other location in which its loads may lie. The heavier loads should be stored close to the mast because the capacity of a crane diminishes with the operation radius.

The other major piece of static plant is the concrete and mortar equipment. Even where most of the concrete is ready-mixed a small mortar mixing area is required. The main item to be considered is the storage of aggregates. These take up quite a large area and temporary works are required for the mixer base and to retain these materials, and if necessary for bulk cement storage.

(v) SPECIAL PROBLEMS

Particular attention may have to be paid to additional factors if special circumstances exist, such as the following:

(a) Confined sites may involve parking restrictions, one-way traffic on approach roads, restricted delivery time-tables for materials, two storey offices or gantries over pavements, etc.

(b) Tall buildings require special arrangements for clocking on and off, the siting of canteens perhaps half-way up, and the installation of passenger lifts or hoists.

(c) Staged completions involving the piecemeal hand-over of buildings or sections and the removal or re-location of temporary installations, necessitates detailed planning of the time and manner of such change-overs, in order to avoid double-handling and disrupting delays.

(d) Adjoining property can introduce complications particularly where demolition is concerned, perhaps the diversion of services, shoring of under-pinning, and precautions such as photographs to forestall possible claims for damage.

SUMMARY

PLANNING THE LAYOUT

The layout will depend on size of proposed building and the space to be left about that building. The main principles should be, to avoid any area where building is to eventually take place, any underground services, any area which may interfere with production, safety or profitability.

SITE OFFICE ROUTINE

DRAWINGS

Three sets of all drawings must be handed to the site by the architect. Any further copies will be at the contractors expense. One copy of all drawings must be available at all times to the architect or Q.S. for use on the site. Care should be taken that drawings are not mishandled and the one copy should be carefully filed to prevent damage or removal.

The copies of drawings on site are usually distributed as follows:

(a) once copy in office for architect or clerk of works properly filed and not removed for other use;
(b) once copy in office of general foreman usually mounted and not for use by workmen;
(c) one copy mounted on hardboard or other boarding and used by workmen for setting out and manufacturing.

Copies of drawings are also forwarded to sub-contractors which relates to their particular work.

DRAWING REGISTER

A register must be kept on site of all drawings received noting the latest amendment numbers. Any drawings issued during the construction of the work must also be noted on the drawing register. Drawings that are superseded must be noted on the register.

FURTHER DRAWINGS

The architect normally issues drawings during the construction of the work which could be an amended drawing or a new drawing containing detail of work which was not issued at the start of the work. These drawings must be similarly treated as previously described. In certain instances the site may require detail drawings or schedules of certain aspects of the work and it is up to the site staff to request such drawings well in advance to obviate delay in the work.

When revised drawings are issued by the architect, the drawings which are superseded must be handed back to the architect or destroyed. Care must be taken that all out of date drawings are removed from circulation on site to prevent different persons working from different drawings.

"AS BUILT"DRAWINGS

All drawings received should be stamped and the date received entered on the drawing. At least one copy of each drawing must be retained for final account purposes so that the "as built" drawing could be compared with the original drawings issued. In certain cases it is advisable to mark the architect's instructions on such drawings to record the specific instruction.

THE USE OF DRAWINGS

Drawings are fragile and all precautions should be taken to avoid tearing or fading. Sunlight tends to fade the drawings and it should not be placed in places where it would be exposed to sunlight. An astute site supervisor will ensure that the architect never finds an old, tatty drawing being used to 'set out' new, critical work.

The edges of the drawing can be bound ensuring that they do not tear or fray.

CONTACT DOCUMENTS

Various documents in the contract form the basis on which the legal contract is signed. As such these documents must be accurate and supplement one another. All these documents are signed when the contract is signed by the contractor and the client.

1. The drawings indicate in diagrammatic form what is to be done under the contract.

2. The specifications indicate how the work is to be done and describes the materials and workmanship required to do the work.

3. The Bill of Quantities shows how much work is to be done with full descriptions of the work and is based on the drawings and spec.

Both last documents are based on the drawings and serves to amplify the drawings describing the items that could not be shown on the drawings. They are therefore supplementary and complimentary with the drawings.

On site it is necessary to consult all three documents for the purpose of doing the work to ascertain the exact nature of the work.

If a discrepancy is found between any of the documents it must be referred to the architect for clarification e.g. the drawing may show the concrete in columns to be 25 MPa and the B of Q gives it as 20 MPa then it must be referred to the architect. If the architect decides it must be 25 MPa then the price must be adjusted and it would be treated as an extra to the contract. This adjustment must be made in the final account. Because of this the site must, at all times, loss for such differences and pas it on to the person concerned at head office. At times the description of an item in the B of Q is not completely in line with the work to be done. This requires also recording and notifying head office e.g. the bill may describe shuttering to beams where in fact the beams are more than one meter deep. According to the standard system such shuttering should be kept separate as formwork to beams exceeding one meter deep.

SITE RECORDS

Sit records evolve mainly around the various things and operations that take place on site. The following are the main site records that should be kept and maintained on site:

(a) **Site Diary**

This is normally kept by the foreman and in which he will enter on a daily basis what is happening on site. Such as

2 March Started setting out.
3 March Completed setting out of ground floor. Ordered sand, stone and cement.
4 March Started digging foundation.
5 March Stone arrived on site. Excav. for foundation proceeding. Contracts manager paid a visit to site.
6 March Concrete mixer arrived on site. Sand and cement delivered. Notified Mun. inspector to inspect.
9 March Inspector passed excavations. Started pouring concrete footings.

(b) **Labour Records**

An accurate record is kept of all labourers, handymen, operators or artisans on site. Also date and time of arrival on site or removal from site and any persons taken on at site stating grade pension number, tax number, salary etc.

(c) **Weather Records**

The type of weather conditions fro each day must be recorded with minimum and maximum temperature, rain etc.

(d) **Hold-ups**

A proper record must be kept of any hold-ups in the progress of the work and reason for hold-up such as rain, waiting for approval of engineer, strikes, shortage of material etc.

(e) **Visitors**

Anybody visiting the site either from head office, the architect, the quantity surveyor, the engineer or public such as students for Technikon must be noted for future references.

MATERIAL RECORDS

Orders for materials are generally placed by the Buying Office from the material list compiled from the Bills of Quantities. Due to lack of storage facilities on site the material is not delivered in one large delivery but as required on site. It is up to the site staff to ask the supplier to deliver the materials in quantities as required on site.

To control the amount of material delivered against the quantities as calculated on the material schedule it is necessary that the site keep records of all materials received. This can be done by:

(a) weekly returns of materials received wherein the site will notify head office of all materials received in that particular week;

(b) materials record book used to record all materials received on site. The entries are made from the delivery note prior to sending the delivery note to head office. A page could be used for each type of material indicating the material and total quantity at the head of the page. A running total can be kept for comparison purposes. A column can also be introduced for the amount used on site that the difference between amount used on site so that the difference between amount delivered and amount used can be checked against the stock on site. Material delivery boards are often used on site especially for bulk materials such as sand, stone, bricks, cement etc, where the amount received is entered and the board will show when new deliveries should be made.

The main reason for material control on site is to ensure that sufficient material is at hand to keep the work flowing and no hold-ups will occur due to shortage of material. A periodic check must be made to ascertain if materials have not deteriorated (cement) been stolen or misused (excessive waste). The control on delivery is very important because short deliveries and materials not conforming to the specification will greatly affect the progress and cost of work.

Certain items, such as ironmongery, should be carefully stored and locked to avoid stealing and one person on site be made responsible for issuing such materials.

Materials transferred from one site to another must be accurately recorded and the necessary credit notes for such materials must be incorporated in the cost structure.

SITE SCHEDULES

Schedules are either

(a) issued by the architect
(b) prepared by contractor.

(a) The architect will issue various schedules such as

1. bending schedules which indicate the type of reinforcing steel, the size and the shape of the steel for various structural components;

2. finishing schedules which will indicate the type of finish for each room;

3. ironmongery schedules which details the ironmongery to various doors;

4. door schedules which will detail all doors and frames and joinery work relevant thereto;

5. window schedules which will give details of the window, the glass, the ironmongery, lintels, jambs and cills.

(b) Schedules prepared by the contractor should be any or all of the following from the program:

1. **Plant schedules**

This would indicate if plant is used from the contractor's own plant resources or if hired. The date and time required must be noted so that prior arrangements can be made to reserve the item of plant for the time required. Any variation in program must be notified to the plant supplier. Plant can be:

(a) mechanical such as concrete mixer, excavation equipment, cranes, etc.

(b) non-mechanical such as scaffold huts, barrows, ladders, tarpaulins, etc.

2. **Site supervision san admin staff**

This schedule would show how many and the time supervision is required to ensure that the required supervision is able and on site.

3. **Labour schedule**

Labour schedule will indicate the number of workmen in each trade required at a specific point of time and to be able to keep up with the program. This will enable the contracts manager to plan ahead in transferring labour from one job to another or to take on more labour.

4. **Schedule of sub-contractors**

Schedule of sub-contractors which is normally divided into two groups:

(a) nominated; and
(b) own sub-contractors.

The schedule should show starting and finishing dates which are usually mutually agreed according to the program.

5. **Material schedule**

Material schedule which has been dealt with before.

6. **Drawing schedule**

Has been dealt with before.

To be able to use the schedules to the full advantage of site it is important to change such schedules according to the progress of the work and notify the relevant instances of the changes. The progress of each of the items scheduled must also be monitored to ascertain what effect the relevant item has on the progress so that corrective steps may be taken.

E.g. not enough labour (artisans) available at a certain point of time.

OR

sub-contractors not starting on time or performing adequately.

LABOUR RETURNS

It is the responsibility of the site to forward details of time worked by tradesmen and labourers to the head office for compiling wages of all labour. The labour returns must show in detail all names and numbers of workmen together with number of hours worked each day of the week, overtime worked and new labour take on at site. As soon as a worker is taken on at site the head office must be notified so that a number disc can be issued in respect of the worker. All labour working on site must be carefully checked and controlled and must balance with labour returns.

Labour allocation sheets are filled in conjunction with labour returns noting the operation on which the operative was employed for costing purposes. This is normally done by coding the various operations and allocating the operative to a certain code in which he was employed – carpenter 007, J/A 008.

Labour transferred to and from the site must be noted on the labour returns as well as jobs from which the labour was transferred or to which it was transferred.

Records must also be kept in respect of apprentices and minors showing time worked and renumeration with details of training.

VARIATION ORDER AND DAYWORKS

The architect will issue variation orders from time to time. This can be done on a pre-printed variation order form but it could also be in the form of a site instruction. In either case the architect has to sign the order or it may be signed by his representative (COW). IN the case of an oral site instruction the contractor must confirm the instruction in writing within 7 days to the architect. If the architect does not dispute the confirmation within 7 days then the confirmation by the contractor will be considered as an architect's instruction.

Because variation orders involves adjustment to the contract price it is important to file the variation orders and keep it safe for purpose of drawing up the final account. A copy of all variations must be forwarded to the head office where the Quantity Surveying Department will work up the rates and prices. A note must be made of the state of the contract at the time the V.O. is received.

A variation order can be issued to charge:

(a) the design of the building (drawings)
(b) the quantity of work (bills of quotes)
(c) the quality of the work (spec and B of Q)

Any change in a P.C. sum or as P.S. is dealt with separately and the value of such variation must be given by the architect.

When calculating the value of a variation the basis of determining the value of the variation is on the prices quoted in the B of Q where these prices are applicable as follows:

(a) using B of Q rates
(b) a fair valuation of the work based on B of Q rates
(c) new prices agreed between architect and contractors
(d) daywork basis

All variations must be measured and priced within three months after completion of the work.

SUB-CONTRACTORS

A Sub-contractor is a person or firm who does work on behalf of the main contractor.

In building work it is difficult for a contractor to perform all the specialised work entailed in a building project. Specialisation therefore takes place whereby different people or trades concentrate on developing and performing one aspect of building work such as roofing, flooring, ceiling, etc. Certain specialised work such as electrical work and plumbing is governed by authorities and require licensed workmen. If a contractor has to employ tradesmen in all these fields he will find himself overrun with administrative and legal organising.

The problem of keeping the specialised workmen busy all the time will require sufficient work in that particular line of work and this is not always possible. Another factor of specialisation is that the work can be cone cheaper due to experience and continuity of work.

Sub Contractors falls into three categories:

1. **OWN SUB-CONTRACTORS:**

   (a) LABOUR ONLY SUB-CONTRACTORS

   Contractors doing work where the labour for the work is supplied but no materials or plant. It implies that this type of sub-contractor does not require financing to a great extend and is usually confined to a certain trade such as brickwork, plastering, etc. Because of their ability to produce the work on a specialised bases the work is usually done quickly and efficiently.

The benefit to the main contractor is that:

(a) Work is done quickly.
(b) Supervision is kept to a minimum.
(c) Administrative work is reduced because he does not have to make up wages etc. for these workmen.
(d) Financing of work is reduced.

DISADVANTAGE

(a) The main contractor is responsible for adequate supply of materials.
(b) Excessive waste usually occurs.
(c) Plant has to be supplied which is not always handled properly and damaged.
(d) Difficult to ge sub-contract to repair damaged work or rectify work that has been condemned.
(e) Maintenance is held on main contract but not usually on labour only on sub-contract.

ADMINISTRATIVE

The appointment of a labour only subcontract is usually on a verbal basis because the persons involved in labour only does not know much about the legal aspects and requirements of the contract.

He just wants to get on with the job and finish it, get payed and go onto the next job.

There are however certain legal aspects that should be kept in mind such as:

(1) Work condemned or not acceptable.
(2) Cleaning up afterwards.
(3) Repair work after plumbers etc.
(4) Maintenance work.

It is therefore clear that a certain type of contract should exist between the main contractor and the labour only S.C. which will clearly spell out the responsibility of the various parties regarding payment, method of valuating the work for payment, making good unacceptable work, etc.

(b) SUPPLY AND FIX SUB_CONTRACTOR

These are specialised firms who will do certain items of work on behalf of the main contractor and involves labour and materials. They have workmen specially skilled in the type of work they are doing and can usually produce the work cheaper. As a result of competition the prices are usually very keen.

The work that is given to these sub-contractors is fully measured in the B of Q and the estimator will received quotations based on the measured quantities from the various firms. These prices are then included in the priced bills of quotes. On acceptance of the tender the orders can be placed with the lowest sub-contractor. The contract requires that the names of all sub-contractors must be submitted to the architect for approval. The contractor is therefore not allowed to employ or place an order with a sub-contractor before the architect has approved of such a sub-contract. The order usually placed on a special sub-contract order form which is signed by both parties (contractor and sub-contractor) and sets out in detail the work to be done usually quoting B of G page and items numbers. The order will also have an order number and states that the same conditions, applicable to the contractor, applies to be sub-contractor.

He is thus also bound by the contract conditions such as penalties, maintenance, retention etc.

Own sub-contractors can also be used for only the supply of items such as windows, doors, frames, etc. This often leads to controversy because such sub-contractors consider themselves as suppliers and not sub-contractors in which case (supplier) they are not subject to retention.

The rates included in the B of Q for this work is considered to be the rates quoted by the contractor even though the rates are supplied by the sub-contractor. In the final account the measured work will be finalised with the contractor and the contractor in turn will settle the account with the sub-contractor. Any extras claimed by the sub-contractor must be submitted by the contractor to the P.Q.S. for inclusion in the final account before the final account is drawn up and agreed.

The fact that the sub-contractor is bound by the same conditions of contract as the contractor does not relieve the contractor from the fact that the sub-contractor's work and performance is solely the responsibility of the contractor. All work done is done on behalf of the contractor and it is up to him to see that the work is done in proper manner and on time.

Programming should be done to incorporate the sub-contractor so that he will know exactly when he should start and when he should

finish. Any variation in the program must be passed on to the sub-contractor.

In the case of a lump sum contract the prices given by the sub-contractor will also be a lump sum. This can involve problems when alterations or N.O. is priced the sub-contractor must be consulted to find that the changes will influence his price. The final account for the Own sub-contractor is solely between the Contractor and the Sub-contractor.

2. NOMINATED SUB-CONTRACTORS

They are also firms who will do certain specialised work on behalf of the contractor with the approval of the architect, the Nominated-sub contractor is appointed and selected by the architect and approved by the contractor.

This fact does not relieve the contractor of his responsibility that the Nominated-sub contractor is his sub-contractor and he is solely responsible for his work and performance.

The method of appointing a nominated Sub-contractor is as follows:

(1) The architect will prepare tender documents for the specialist work.
(2) Tenders are invited usually based on drawings and specialist work.
(3) The architect selects a successful tender.
(4) The architect will write to the contractor advising him to place an order for the specialist work with Messrs XYZ for the work for the sum of R.....
(5) The contractor can reject the nominated sub-contractor as long as his reasons are not unreasonable.
(6) The contractor is also **asked** to enter into a sub-contract agreement on the prescribed sub-contract form.
(7) The nominated sub-contractor now becomes a sub-contractor to the contractor and is the responsibility of the contractor.
(8) The final account of the nominated Sub-contractor is the responsibility of the architect.

The relationship between the contractor and the Nominated sub-contractor is spelled out in the white form of contract Sub-contract works.

Nominated sub-contracts area also firms doing specialised work such as electrical installation, lifts, ventilation, steel reinforcement, steelwork etc. and usually includes designs of the work. The sum allowed in the B of Q is an estimated cost of the work and the sum includes 5% cash discount to the contractor. Together with the P.S. an item is measured wherein the contractor can allow for any additional profit that he would like to allow. Another item is for attendance, provision of scaffolding and making good after the Nominated Sub-contractor. The later two items are not adjusted in the final account of the P.S.

The contracts form states that:

(1) The sub-contractor must be given the opportunity to study the documents of the main contract.
(2) The sub-contractor shall execute and complete the work to the satisfaction of the contractor. All excess material and rubbish must be cleared by the sub-contractor.
(3) All conditions of the main contract applies to the sub-contractor and he shall take full responsibility for breach of contract, any omission by workmen, negligence by workmen and insurance against injury to persons, etc. Insurance of the works by fire or by other means must be done by the contractor.
(4) The sub-contractor alone is responsible for plant, tools and equipment used by him.
(5) Any variations of instruction given to the sub-contractor by the contractor shall be compiled with Verbal instructions and can be confirmed in writing.
(6) The sub-contractor shall start the work when require to start and should be given a program. The contractor can in writing require the Sub-contractor to start work within 7 days of such letter. If the sub-contractor fails to complete the work in time he shall pay the contractor all damages that may be suffered as a result thereof. Extension of time can be given if to sub-contractor for reasons beyond his control.
(7) Defects in sub-contract work must be made good by the sub-contractor. If the contractor must do rectifying work then the sub-contractor can be changed for the contractor.
(8) The final account sum shall be the price named plus any variation thereto.
(9) Application of payment for work done by sub-contractor shall be submitted by the contractor on behalf of the sub-contractor. The contractor need not pay the sub-contractor until he has been paid. The amount due to the sub-contractor less retention must be paid within 10 days of payment by employers. If the payment is made later, then the contractor will loose his discount and interest must be paid.
(10) Failure by contractor to claim or failure to pay interim payment will entitle the sub-contractor to cease work until he has been paid and that time will be an extension of time.
(11) The employer can finalise and fully pay a sub-contractor for his work completed.
(12) Retention money is held on a sub-contract in the same way as for the contractor. Interest must be paid on retention money of the sub-contractor if the sub-contractor's sum exceeds R30 000.00.
(13) The contractor and the architect should at all times have access to the premises or factory of the sub-contractor.
(14) The sub-contractor shall not sublet any of his work without permission.

(15) The contractor shall supply water and electricity to the sub-contractor including a temporary workshop, store, office and the use of a telephone.
(16) The Sub-contractor shall supply his own scaffolding but may use the contractor's scaffolding while in use and erected.

3. SELECTED SUB-CONTRACTORS

This is a type of Sub-contractor introduced with the standard conditions of contract issued in 1991. The main contractor and the design team will select the Sub-contractor together. This Sub-contractor normally replaces the nominated Sub-contractor. The only difference is that the client cannot be obligated due to mal-performance of the Sub-contractor.

4. GENERAL ON SUB-CONTRACTORS

The contractor as the main contractor is responsible to co-ordinate all activities.

The Sub-contractor must be programmed and scheduled in with the main contract work and with one another so that no interference or delay in the various activities will occur. Regular liaison between the various sub-contract and the contractor should take place to raise all items of interest to the parties. Time tables with starting and completion dates is most necessary with notification thereof to all concerned. The placing of sleeves or chases and holes in walls must be located mutually. Requirements such as facilities storage, workshops, etc. must be agreed and provided.

A careful note must be made of all daywork to be claimed on behalf of the sub-contractor and any contract changes that must be made to the sub-contractor must be noted and passed on to the head office for charging out to the sub-contractor.

FINISHING AND CLEARING THE SITE

A. DEFECTS

Any defects in the work or latent defects are the responsibility of the main contractor. This applies to the contractors own work an sub-contract work.

Defects refers to work which does not comply to the drawings and the specification and requires rectification by an order from the architect. It can be wrongly done or work that has not been done.

Latent defects are parts of the work which appears correct at completion but shows up faulty at a later stage due to poor workmanship or inferior materials.

The architect must compile a list of all items of work to be done when the practical completion certificate is issued. This list will bind both parties as follows:

(1) Employer is bound by the list of the architect and cannot demand more than that.
(2) Contractor is bound to rectify all work stated in the list. No more items can be added by the architect or the employer except for latent defects.

As soon as all the defects has been rectified by the contractor he will give written notification to the architect and the architect must then inspect the items and if satisfied issue a certificate of completion.

All making good defects must be done within the maintenance period. From the contractors point of view, the work should be done as quickly as possible and approved by the architect to avoid additional cost of persons having to be retained on site or workmen transported to and from the site to do rectification of the work.

After work on the list of defective items has been complete the architect will issue a completion certificate which will mean that the work has been successfully completed to the satisfaction of the architect.

The contractor is also responsible for any defects on the part of the sub-contract and he must arrange for these people to rectify their work. The financial aspect of completing the work as soon as possible lies in the fact that retention and other monies such as the final may not be released as a result of the defects not made good and this will influence cash flow.

Clear Site

The removal of all temporary structures, plant, stones, huts and rubbish together with surplus material is the responsibility of the contractor. The contract documents usually require the work to be left tidy and clean. This will include cleaning floors, window, etc.

Failure on the part of the contractor to remove the above items can be considered as breach of contract in which case the employer can have the work done by other contractors and charge the contractor for all costs incurred. It must be noted however that any materials removed can only be done on instruction from the architect. When material is found unsatisfactory then he will order the removal thereof. Any surplus material can only be removed on authority of the architect.

Handing Over

The work is handed over at issue of practical completion certificate when a list of snags (defects) will be given to the contractor. The contractor must have a representation to accompany the architect during inspection of the work to ensure that the items are properly indicated and referenced.

On handing over the site it is important to ascertain who takes responsibility. The client will be responsible for all security, insurance etc. after handing over. The building now becomes his responsibility and any other obligation regarding watching etc. will transfer from the builder to the employer. There are certain items which must be arranged by both the contractor and the employer such as electrical and water connections fees. The time aspect could be critical in respect of these because of the delay on the part of the local authority.

During maintenance inspections, the contractor must ensure that all items are recorded into written reports where all marks or damage to the work as a result of the employer occupying the building is recorded. If any changes or installations are done by the owner during the maintenance period then these should also be carefully noted. By doing this, a lot of arguments as to the responsibility of the defects could be avoided.

QUALITY CONTROL

The aim is to ensure that all work produced is as it was intended to be by eliminating defects and variation from the standards as required. Through this also avoid waste of materials and time and therefore reduce costs. Defective work which has to be broken down and re-done does not only involve the additional cost of breaking down and re-building but will also affect progress and planning which again has a detrimental effect on cost.

Certain standards are set for work on site in the drawings, specification and in the bills of quantities. The contractor tenders and sign the contract on the understanding that the work must be done according to the requirements of the contract documents and to the satisfaction of the architect. To ascertain if the work meets these requirements a strict control must be exercised.

The control for quality has various resultant aspects.

(1) Reduce additional cost for re-doing the work. This cost is not included in the tender and is therefore a total loss to the contractor.
(2) Image of the firm. The architect will judge whether the work is up to standard and if not he may be reluctant to award work to the firm in future. Also public watching the building operations will notice if work is being re-done and this will give a poor image. The persons watching may be prospective employers.

(3) Psychological affect on workers. Workmen do not like to do work over again and if this happens they will become upsent and disgruntled. They do not like to rectify other peoples' mistakes.

Quality control is usually related to

(a) Material. The material delivered to site should be checked for quality in addition to quantity, to make sure that it complies to the specification and requirements of the contract. The architect normally approves samples of certain materials such as bricks, sand, stone, water, etc. and deliveries should comply with the samples originally submitted. Joinery and other manufactured articles must be carefully checked and the architects approval obtained before these items are built in.

(b) Workmanship. The method of doing the work is normally described in the specification and all work should be within the tolerances laid down. Often samples of work is prepared such as a panel of facebricks which, once accepted by the architect should be the norm that is set for all future facework done on the works. It should be noted that the sample work must be of a standard which could be maintained during the whole building operation. Doing a perfect job of the sample work could lead to lots of problems and controvecy in future.

(c) Sub-contractors. Although sub-contractors may be separate firms working on the same contract, they are still the responsibility of the main contractor and he is responsible for the work done by such sub-contracting firms. It is thus necessary that control on their work is given the same priority as that of the contractors own work. In this respect it would be necessary to obtain approval of their work before the subbies move off site, otherwise it will be difficult to get them back and rectify the work.

(d) Protection of completed work. Work that has been completed should be adequately protected from damage such as failing objects or soiling from mortar or other droppings or overloading on structural members, before they reach a working stress. The problems due to one trade following closely behind another and previous trades being damaged by subsequent trades could prove very expensive as in the case of a plumber following after the bricklayers and chopping holes in the brickwork already built, for their pipes.

(e) Sequence of items. With proper planning the sequence of doing the work would ensure that certain items are not forgotten and has to be done afterwards resulting in breaking into completed work. Example of such items are electrical conduits which are chased into a wall already plastered.

(f) Setting out. The setting out of work must be controlled so that all work are to the lines and levels indicate on the drawings. Erroneous sizes and measurements will cause work to be broken down and set out again resulting in loss of materials, time and labour.

(g) Maintenance work. This item usually cause a great deal of delay in finalizing the contract. At the completion in finalizing the contract. At the completion of the contract at architect will issue a list of defects. By proper control during the running of the contract this list can be reduced to a minimum resulting in smaller cost for maintenance. The defect should be rectified as soon as possible to enable site staff to move off the job and be available for other contracts. The final account could be delayed due to maintenance not being completed as well as the release of retention money which could affect the cash flow of a firm.

The supervisor carries a large responsibility in respect of quality control and he should pay special attention to the following:

(1) Make sure that materials delivered are according to requirements.

(2) Ensure pre-fabricated items are acceptable on delivery.

(3) Check sub-contractors for materials and workmanship complying with the requirements.

(4) Ensure that all workmanship is in accordance with the accepted standard and as specified.

(5) Timeous ordering of materials to ensure constant quality especially in the case of facebricks where different batches could be different in colour.

(6) Protection of completed work.

(7) Carry out necessary tests on site or in laboratories such as slump test, cube tests and preliminary testing of water supplies or drains so that the final test does not fail and involve a large amount of rectification.

(8) Inspection should be made regularly to determine deviations and thereby corrections can be made before the fault has spread.

(9) Notify interested parties and obtain approval before work is covered up to obviate uncovering the work of inspection.

(10) See that setting out is done correctly to the proper lines and levels.

(11) Keep maintenance work to a minimum and rectify defects as soon as possible.

(12) Create conditions which will ensure good quality of work by supplying the right tools, employing workmen with the necessary skill, planning work properly so that the work will not be affected by adverse weather and ensure suitable work space and conditions.

(13) Give clear instructions to workmen so that they know the required standards.

Quality control can be either

(1) Retrospective. This means that the control is carried out after the work has been done. This lends itself to manufactured articles where it is possible to check the quality during the process of manufacture or to concrete where the strength of the placed concrete can only be determined when crushing tests were done.

The method of testing and control on concrete would be compile a list of various tests and record the results: e.g. for 20 MPa concrete the following readings may be recorded.

1	20,52	8	19,54
2	29,15	9	30,87
3	24,16	10	23,66
4	28,25	11	19,80
5	18,32	12	20,78
6	26,35	13	21,77
7	22,23	14	21,96

Compile a frequency distribution chart to indicate the results in the various classes.

Class	Frequency	Total
18-20	111	3
20-22	111	4
22-24	11	4
24-26	1	1
26-28	1	1
28-30	11	2
30-32	1	1

These results can be plotted in the form of a histogram indicating the distribution of the results and control should be tightened on this item to prevent additional cost of making the concrete too strong.

(2) Progressive control is the continued control as the work proceeds. If quality control is done on a progressive basis then the problem areas will be discovered at an early stage when corrective steps can be taken.

Costs	1	2	3	4	5	Plant	Matls	contract	O/H	Total

Nelson Mandela Metropolitan University

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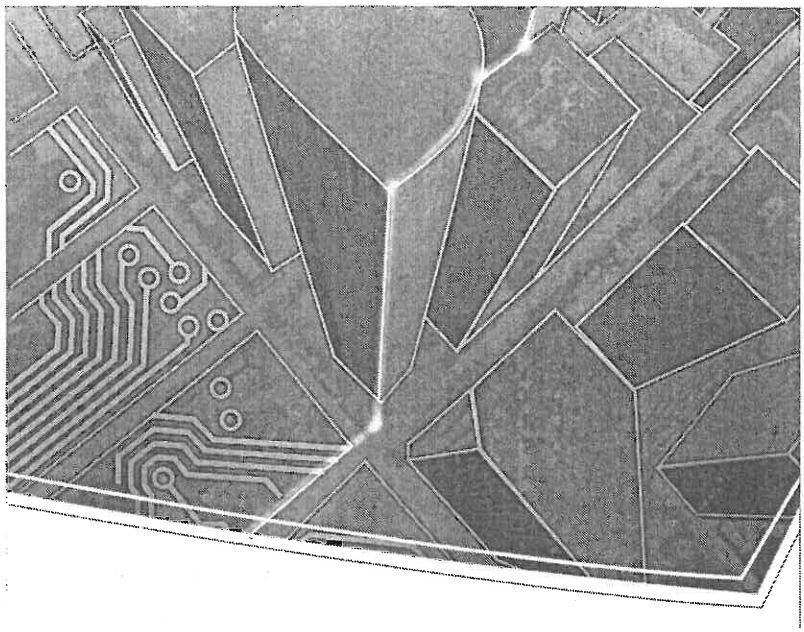
Faculty of Engineering,
The Built Environment & Information Technology
Technology for tomorrow

Department of Building & Human Settlement Development

Subject: Construction Management 3
Subject Code: DCO 3010

MODULE : Programming



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Objectives of Chapter 1

1. The student must be able to generate a network for a structure using the precedence type network.
2. Analyse the network by calculating stating completion dates and float.
3. Generate a programme for repetitive activities using the time of balance method.

CHAPTER 1

Before starting on this module you will have to revise Chapter 5 of the first year course. Once you understand the work in the mentioned chapter you may proceed to this section.

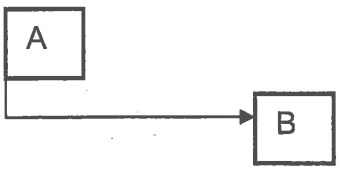
PRECEDENCE DIAGRAMS

The precedence network is a special type of AoN-network. The distinction lies in the fact that it shows more relationships that only the end-to-start relationships or "normal", i.e.

This implies that the start of B is dependant on the completion of A.

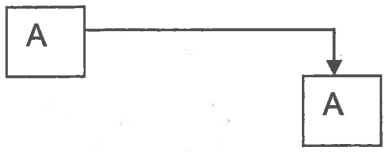
Precedence networks also include other relationships, i.e.

(i) Start to start relationship



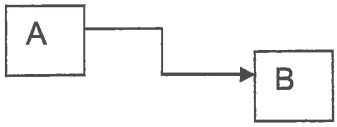
This implies that B cannot start until A has started.

(ii) Finish to finish relationship



This implies that B cannot finish until A has finished.

(iii) Lag finish start ("Lag" indicates that the succeeding (following) activity must be delayed – it lags behind the preceding one)



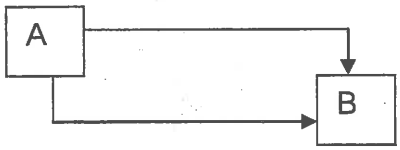
(iv) Lag start to start

This implies that B may not start within two days after the completion of B. This may for example occur when a curing time of 2 days is required, after the concrete had been cast, (a) before the shutters may be stripped (B).

(v) Lead finish to finish

This implies that B may not finish until three days have lapsed after A was completed. (The completion of B must be lead 3 days in front of the completion of A).

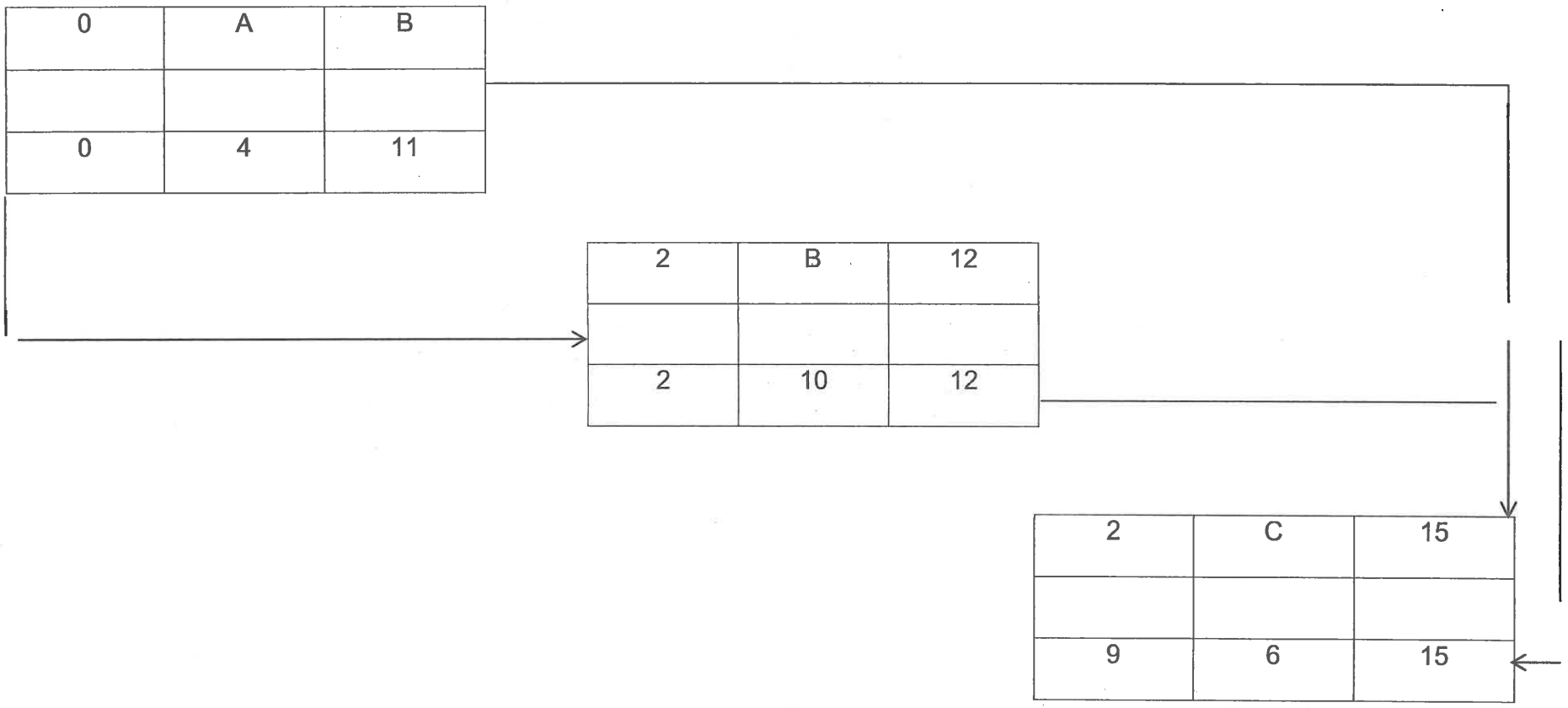
(vi) Lag start to start and finish to finish

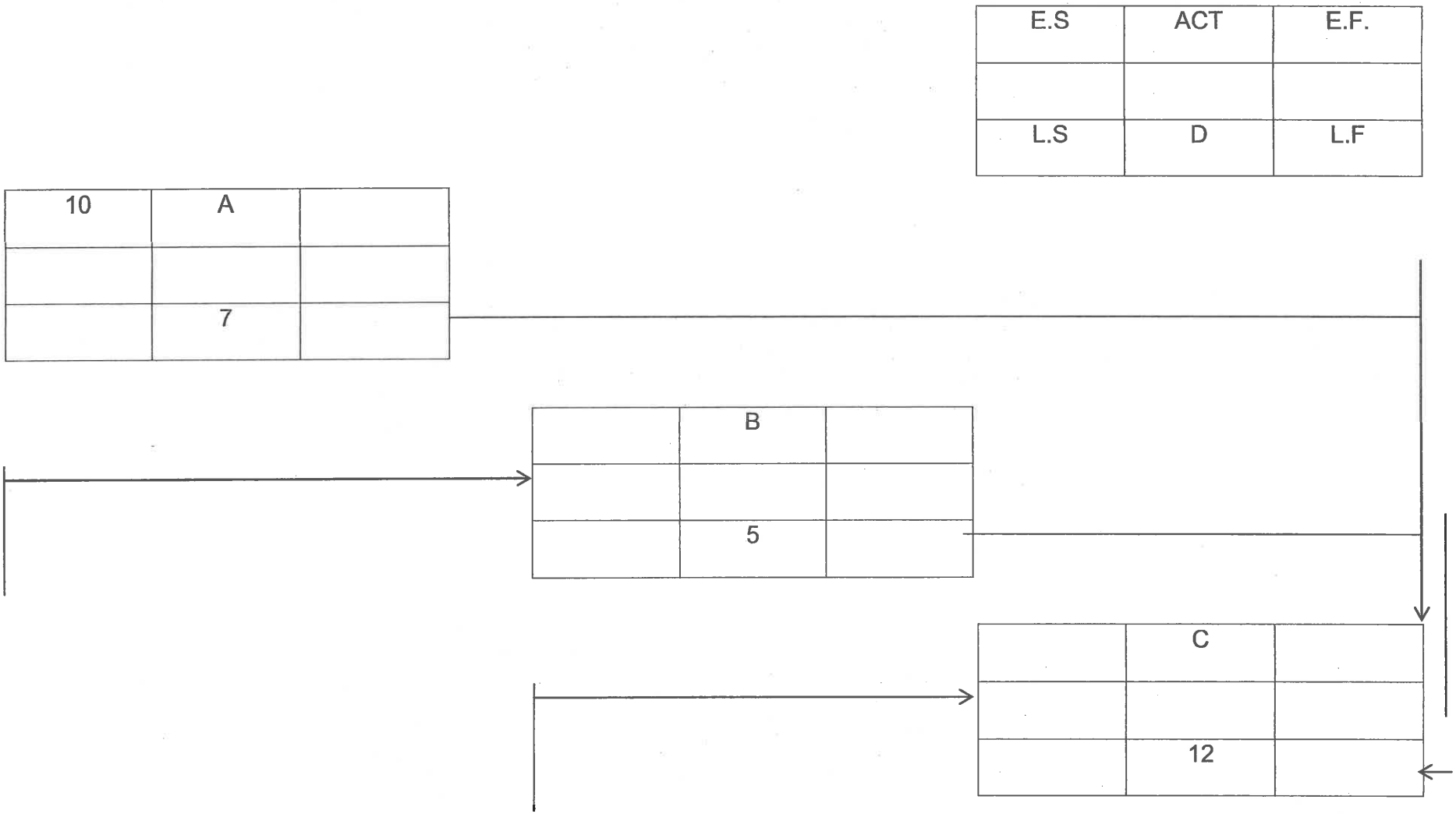


This implies that B may not start within two days after A had started AND B not finish until one day after A had been complete. To explain this, assume A is the activity "Lay pipe" and B is the activity "backfill trench". If two days are required to lay the first section of pipe then backfilling can only start two days after A had started. If one day is required to backfill the last section, B cannot be completed sooner than one day after A is completed.

EXAMPL E OF TYPICAL PRECENDENCE NETWORK

E.S	ACT	E.F
L.S	D	L.F

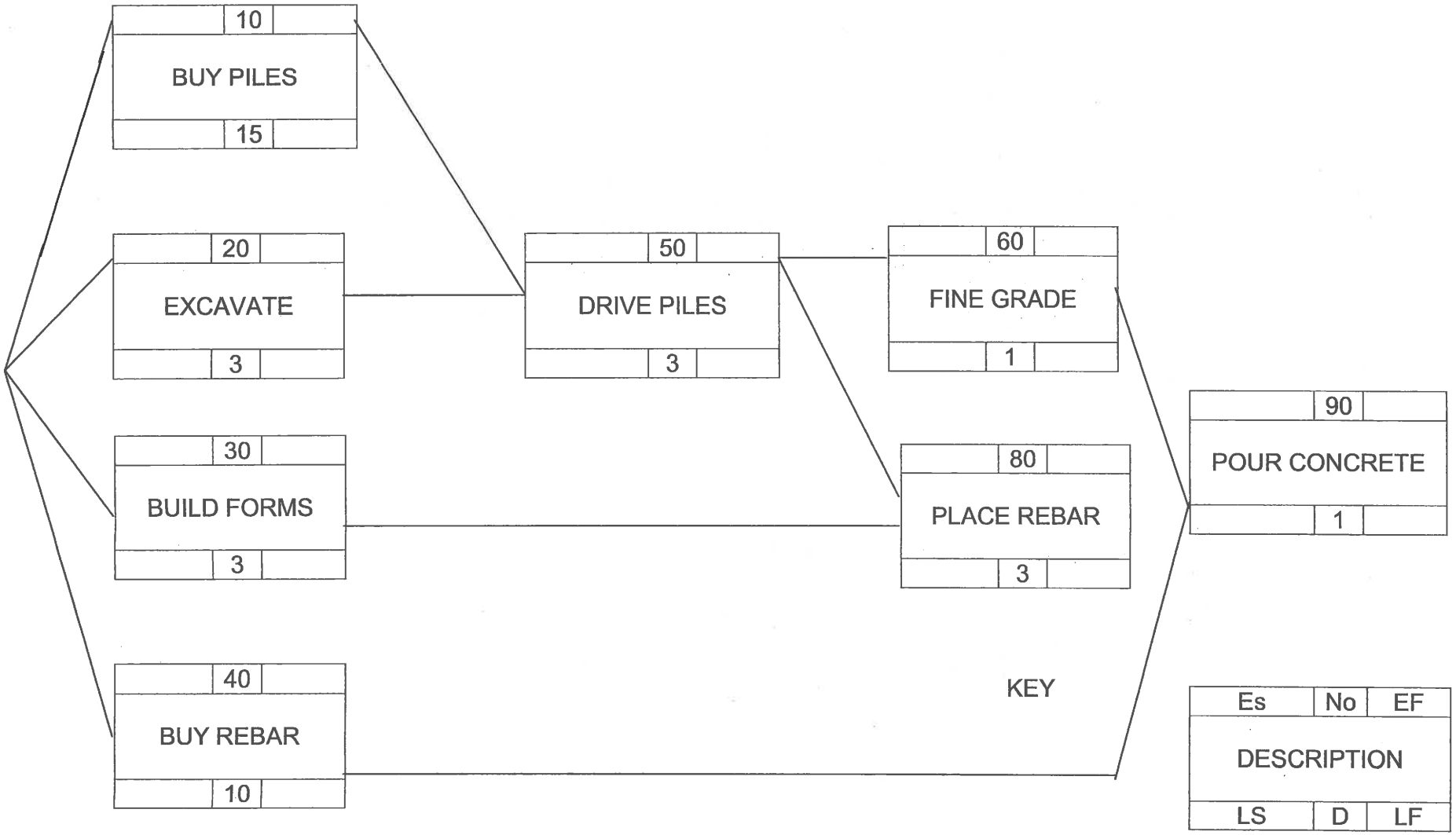



E.S
ACT
E.F.
L.S
D
L.F
10
A
7
B
5
C
12

COMPLETE THE NETWORK AND DETERMINE THE CRITICAL PATH

FOUNDATION CONSTRUCTION

PRECEDENCE DIAGRAM



READ THE FOLLOWING CASE STUDY AND DRAW THE RESULTING PRECEDENCE NETWORK. ANALYSE THE NETWORK AND DETERMINE THE CRITICAL PATH.

FAN OVEHAUL: A PLANNING MEETING

A planning meeting had been called in the office of the Project Manager, George Orwell Mills (G.O.M.) to discuss two fans which are to be overhauled as part of the project at Bicville. Present at the meeting are:

- Fred, who is concerned with the fans themselves and the runners.
- Mike, who is the motor expert.
- Ben, who is a specialist in bearings and will look after that part of the job.
- Sally, the scribe.

G.O.M. Hi guys, nice to have you here for yet another b.... planning meeting. These things sure drag on but if we are going to get it right on the job we had better get it right on paper first – easier to rub than break down, you know – ha-ha.

As joy know, we're looking t the fans which we can start to rework once the maintenance guys have washed off the gas and air ducts.

FRED Ja – well, you see for me it's an easy job. Once we get into the job I can inspect, repair and test the van controls, inspect the casing and do a crack test on the runners all at the same time.

G.O.M. Those three activities aren't all. What about more work on the runners and casings?

FRED O.K. after the crack test on the runners and the inspection of the casings, I can repair the runners and casings and then clean up the fans themselves. And that's me complete.

G.O.M. Thanks Fred. Ben what must your crews do –Ben—are you with us?

BEN hey – Oh, me – These meetings get on my ....., sorry Sally but I don't see why we can't go out there and do the job ... why all the talk... man, we just produce paper.

G.O.M. Come on, Ben – we've got to work this out.

BEN O.K. well, the maintenance guys must give us access and then we move in, remove the bearing themorcouples, overhal then and stick them back. We can also drain the bearing oil, clean the housings, bed and box up the bearings and stick in some new oil.

G.O.M. Just like that?

BEN Ja – just like that – quick and easy.

FRED He'd better not drain the bearing oil till I've done the crack test on the runners.

G.O.M. That's right. Also Ben, you can't clean the housings till you have removed the thermocouples.

BEN O.K. .... O.K. .... you guys know we always get it right, so don't fuss.

SALLY I hoe, Mr Mills, that someone will remember that the thermocouples must be re-installed before the new bearing oil is put in. You remember that someone forgot last time and we had to drain and replace the new oil.

G.O.M. Ben – will someone remember?

BEN O.K. – but why don't you stick to your job – you're not an engineer like us.

G.O.M. Mike what do you do?

MIKE Right, after Ben has removed the bearing thermocouples, we move in, disconnect and remove the fan motor cables, uncouple the fan motors and take them to the shops, dismantle and clean in the shops, overhaul them in the shops and bed the bearings.

G.O.M. The last four activities being done in the shops?

MIKE Yes, when the shop work is done, when Fred has cleaned up and when Ben has finally got the oil, we can re-install and align the motors.

G.O.M. When do you re-install the cables?

MIKE That can actually happen after Fred has cleaned up. After the motors and cables are back we can reconnect the lot. After that, quick look at the 6,6 kV Board and it's all done.

G.O.M. thanks chaps, we'll get this logic down in network format and meet later to look at activity durations and resources requirements. Can you all make up your minds as to how much time and what resources you require. Let Sally have the schedules this afternoon.

How many activities ahs each guy got, Sally?

SALLY It looks like Fred – 5, Ben – 7 and Mike - 9.

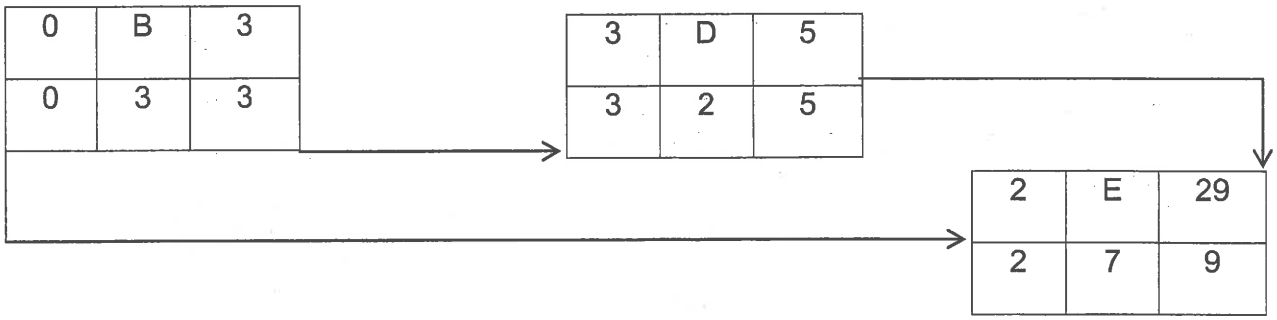
CAN AND CANNOT SPLIT

One may however sometimes have activities that may not be stopped once they have been started, i.e. they must be continuous. It is for example extremely important not to stop the operation of a sliding shutter. This type of activity that may not be interrupted is referred to as a "cannot split" – activity in precedence networks. This can – or cannot split characteristic of activities affect the scheduled dates on the network.

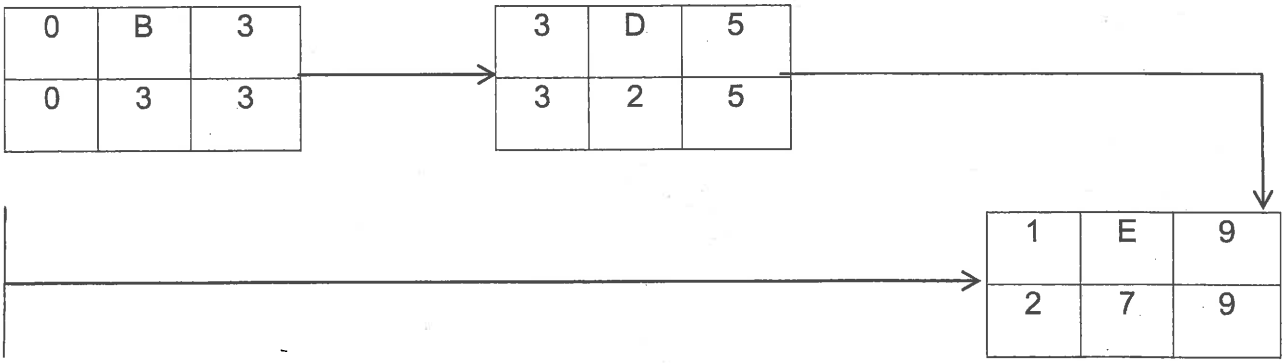
The example below indicates the difference in scheduled dates for the two different cases:

E.S.	A	E.F.
L.S	d	L.F.

CANNOT SPLIT:



CAN SPLIT:



EXERCISE 1

Analyses the following network (calculate E.S. -, E.F.-, and L.F.- dates and total float assuming that:

(i) Activities can split: take larges L.F. unless it affects completion data.

(ii) Activities D, F, and G cannot split. Always take smallest L.F.

NOTES

All cols	:	600m x 300m
All bases	:	1.200 x 1.200 x 0.750
All beams	:	450 x 600m
All slabs	:	250m powerfronted

EXERCISE 2

Draw the precedence network for the following small office block. Find the C.P.

SMALL OFFICE BUILDING

EXERCISE 3

PLANNING TECHNIQUES

MODULE 3: LINE OF BALANCE PROGRAMMING CONTENTS

CONTENTS

STUDY OBJECTIVES

After attending lectures, studying the relevant material and completing the tutorial you must be able to:

1. List five examples of the type of structure for which the L.O.B. technique is best suited and state the unique characteristics of this type of structure by writing it down.

2. Demonstrate your ability to apply the technique by performing the required calculations and drawing a programme schedule for a project of which the relevant data is provided.

3. List the steps that must be followed in performing the calculations for a L.O.B. schedule by writing down the five steps involved.

1. INTRODUCTION

In construction there are some projects in which a predominant feature is that of repetition. The following are typical examples:

1. Housing contract
2. Piling contract
3. Capping piles
4. A block of flats
5. A hotel with a series of identical rooms etc,.

For such work it is extravagant, as well as difficult, to draw and maintain critical path networks illustrating the detail of the construction process for each of the units involved. The updating of such a network and its use as an instrument of control for the delivery of material and each individual construction operation presents many problems of organization. The discipline and logic of networks can, however, be employed in a more rational way for such projects by suing the line-of-balance method.

The line-of-balance method is based upon the establishment of a required delivery programme for completed units. From this programme requirement and the dependency and relationship of foregoing activities on it, a schedule can be prepared for the delivery, manufacture or construction of the various parts which go to make up the whole.

2. LINE OF BALANCE CONTROL CHART AT A CERTAIN DATE – A STEP BYSTEP EXAMPLE FOR PRODUCING A PROGRESS (CONTROL) CHART FOR A MULTIPLE HOUSE CONSTRUCTION PROJECT AT A CERTAIN DATE

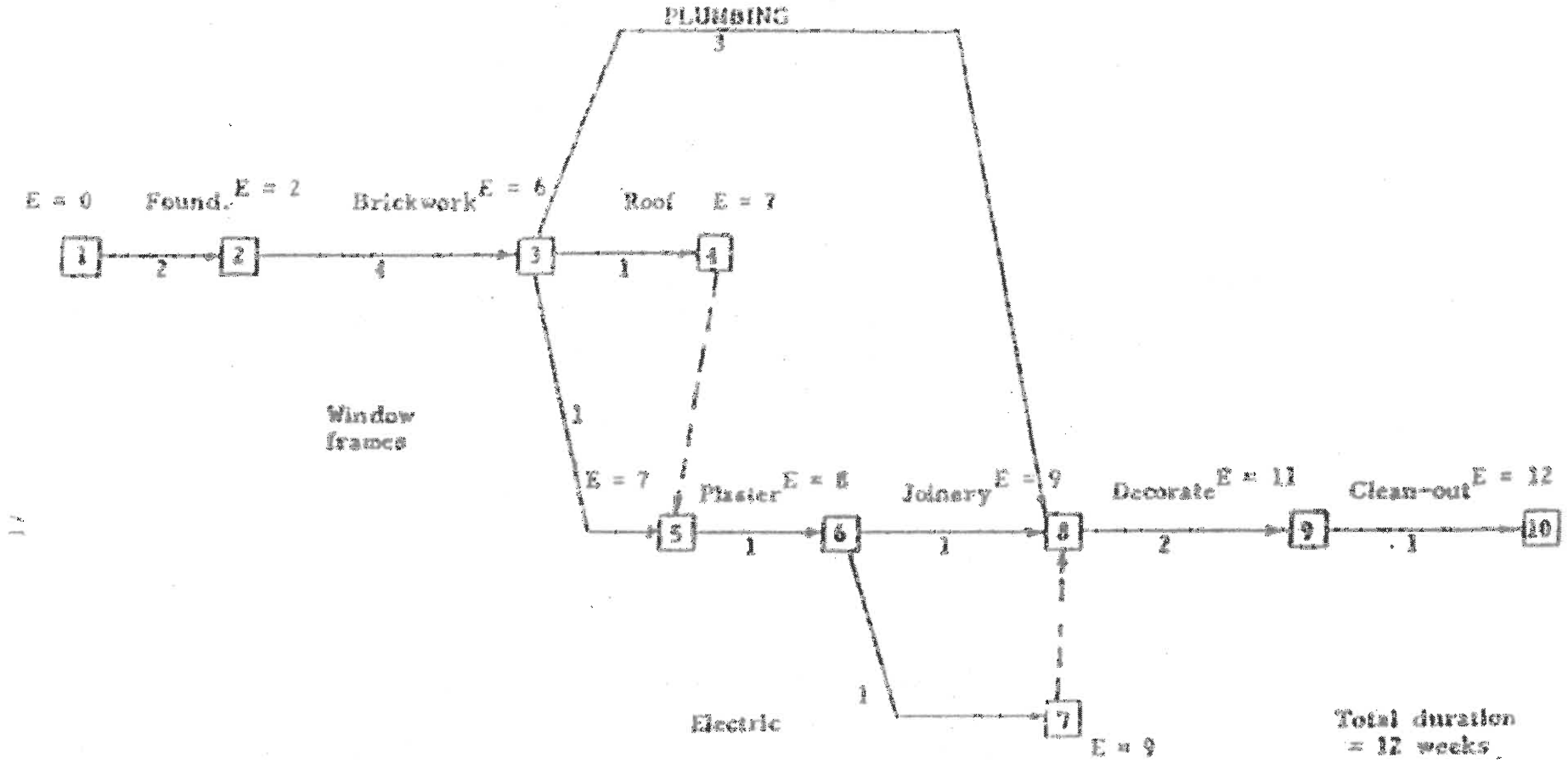
Example 1

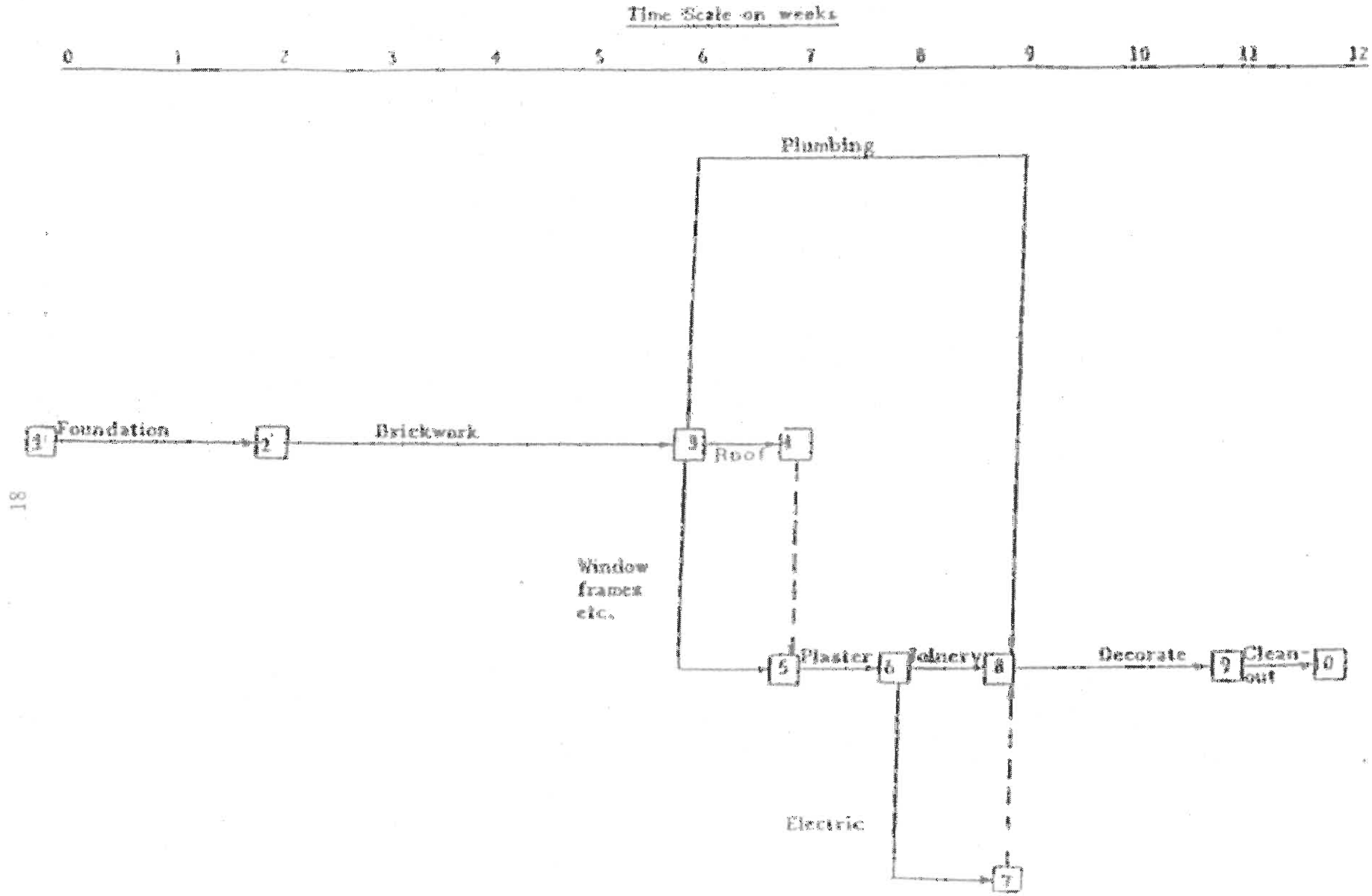
For a housing project one unit of housing is made up of the activities shown below; alongside the duration of each:

ACTIVITY	DURATION (Weeks)
Foundation	2
Brickwork	4
Roof	1
Window frames etc	1
Plumbing	3
Plaster	1
Joinery	1
Electrics	1
Decorate	2
Clean-out	1

These activities will be repeated on all the housing units.

The following network can be drawn up for one unit:


PLUMBING
3
E = 0
Found.
E = 2
Brickwork
E = 6
Roof
E = 7
1
2
2
4
3
1
4
Window
frames
1
E = 7
Plaster
E = 8
Joinery
E = 9
Decorate
E = 11
Clean-out
E = 12
5
1
6
1
8
2
9
1
10
1
Electric
7
E = 9
Total duration
= 12 weeks


Time Scale on weeks
0
1
2
3
4
5
6
7
8
9
10
11
12
Plumbing
1
Foundation
2
Brickwork
3
Roof
4
Window frames etc.
5
Plaster
6
Joinery
8
Decorate
9
Clean-out
10
Electric
7

From this information, i.e. activities, durations, and network we can now establish our control points and lead times.

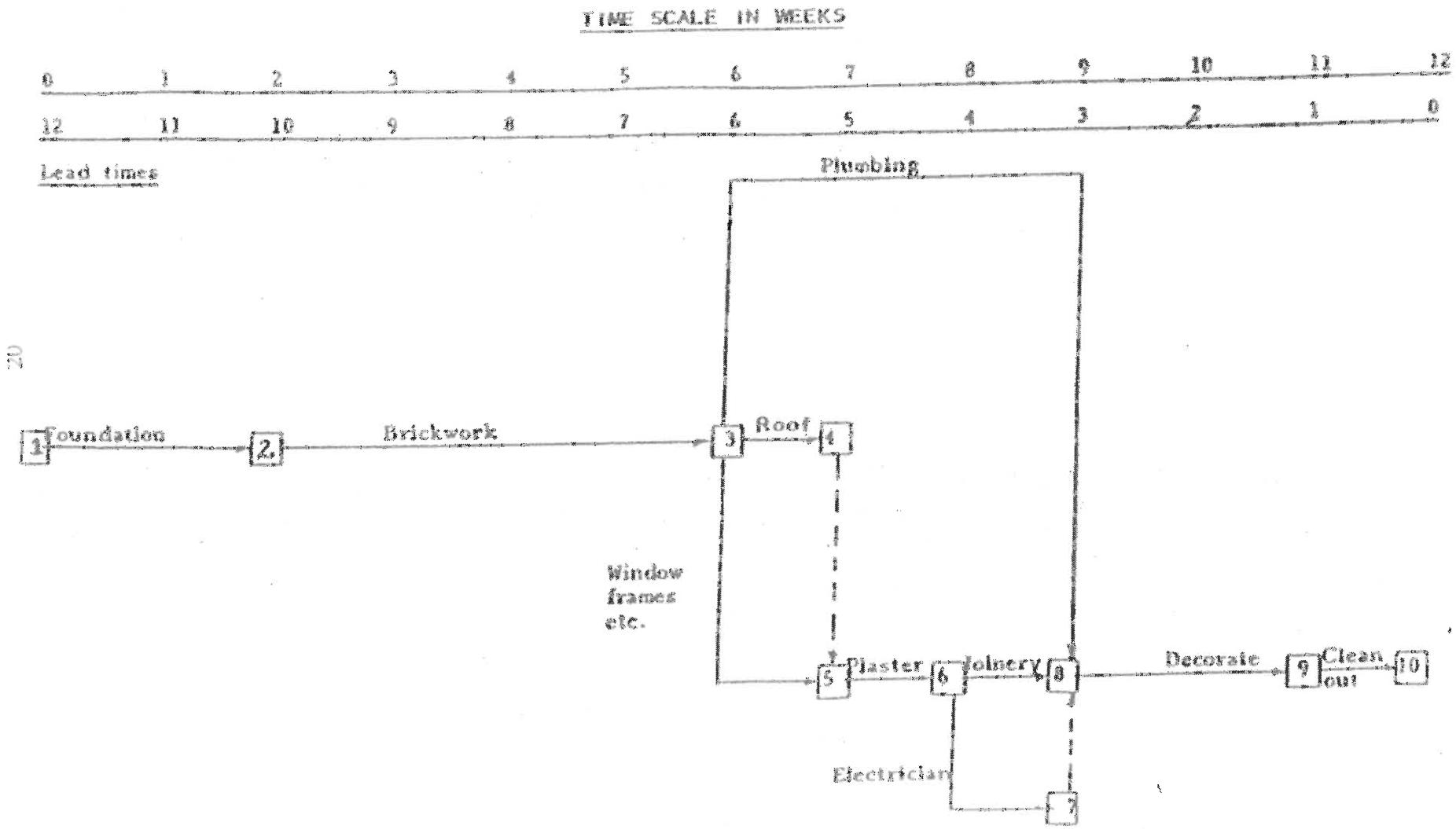
CONTROL POINTS

Our networks which we were given contain activities (indicated by the arrows) and events (indicated by a block with a number). Thus for the given network we have for instance event no 6 (►6-) which is the end event for the activity "Plaster" but the start event for the activities "Joinery" and "Electrician". We are however only interested at this stage with the end events which signifies the completion of an activity. Thus were are interested in event no. 2 which is the completion of the foundations and event no.8 for example, which is the event where "Plumbing", "Joinery", and "Electrician" are completed. These end events we will call "control points". For the network we have the following control points:

1. Start
2. Complete foundations
3. Complete brickwork
4. Complete roof
5. Complete window frames etc
6. Complete plaster
7. Complete electric
8. Complete plumbing and joinery
9. Complete decoration
10. Clean out

LEAD TIMES

The lead times represent the number of weeks (in this case) by which the particular event must precede the end event if delivery is to be made on time. For instance if we must have completed one house after 12 weeks, then 10 weeks before this completion date, the foundations must have been completed in order to deliver or complete the house on time. Thus we say, the completion of the foundations has a lead time of 10 weeks.


TIME SCALE IN WEEKS
0 1 2 3 4 5 6 7 8 9 10 11 12
12 11 10 9 8 7 6 5 4 3 2 1 0
Lead times
Plumbing
1 Foundation
2 Brickwork
3 Roof
4
Window frames etc.
5 Plaster
6 Joinery
8
Decorate
9 Clean out
10
Electrician
7

To calculate the lead times for our control points, we can do the following:

(a) the time-scaled network
(b) our basic network

On the network we have already calculated

(i) our total duration and
(ii) our early start and early finish for the events.

i.e. for event no.6 (our finish event for the plaster) we have the value of E = 8. Bear into mind that event no.6 is the control point 6 – complete plaster. The lead time will be: the total project (one unit) duration – finish of event no.6 = lead time.

i.e. 12 – 8 = 4

So control point 6 has lead time of 4 weeks, or we need 4 weeks after the completion of the plaster to finish the house. In this manner we can calculate the lead times for all the control points.

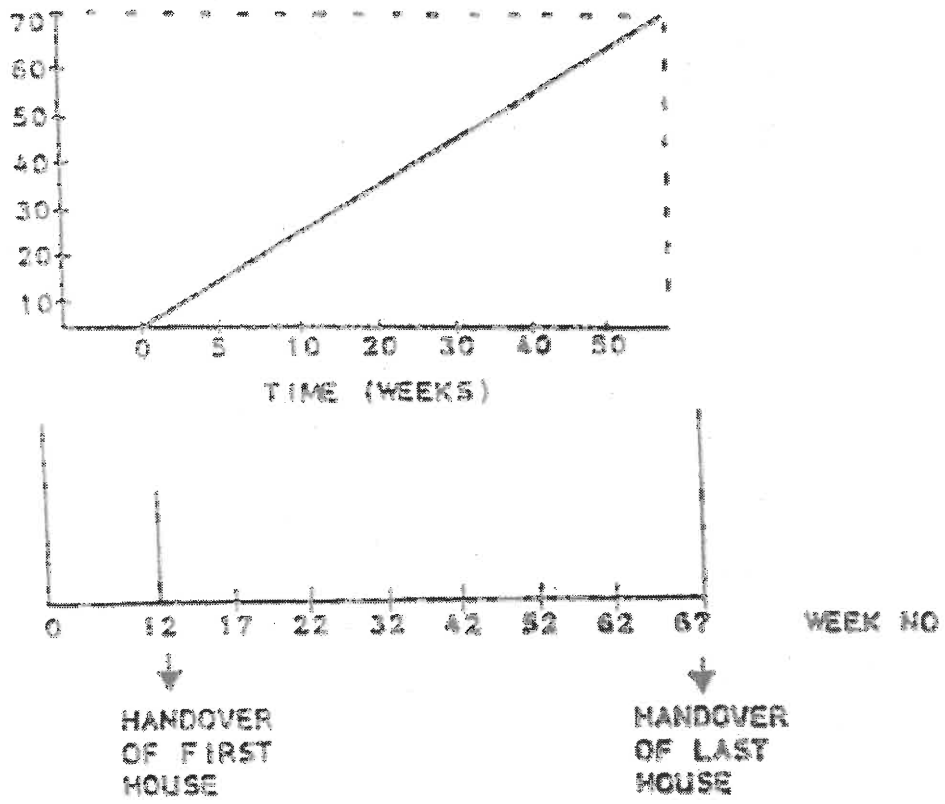
Control points	Total	"E"	D –E = Lead time
1. Commence	12	0	12 - 0 = 12
2. Comp found	12	2	12 - 2 = 10
3. Comp brick	12	6	12 - 6 = 6
4. Comp plaster	12	8	12 - 8 = 4
5. Comp window	12	7	12 -7 = 5
6. Comp plaster	12	8	12 - 8 = 4
7. Comp electrics	12	9	12 - 9 = 3
8. Comp plumb	12	9	12 - 9 = 3
9. Comp decorate	12	11	12 - 11 = 1
10. Comp clean	12	12	12 - 12 = 0

"E" is the earliest starting date at the control point.

From our two networks we conclude that the lead times for our control points will be:

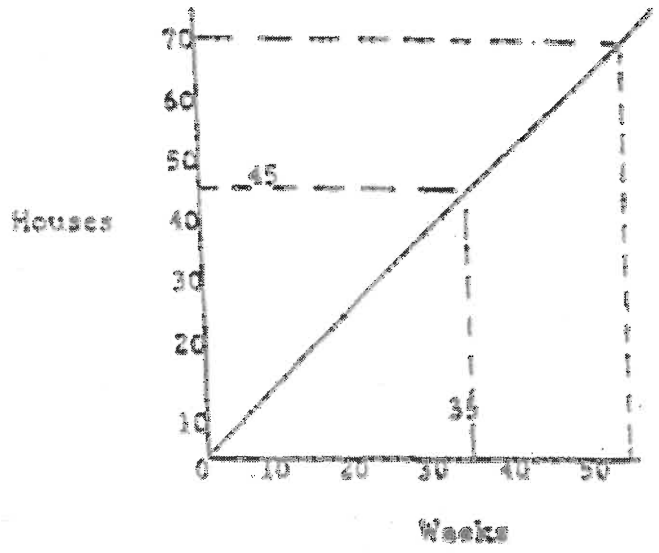
CONTROL POINT		LEAD TIME
1.	Commence	12
2.	Complete foundations	10
3.	Complete brickwork	6
4.	Complete roof	5
5.	Complete plaster	4
6.	Complete electrics	3
7.	Complete plumbing	3
8.	Complete decoration	1
9.	Clean out	0

If our example states that we must hand over 70 houses in 55 weeks we can draw the following graph for handover of all the houses:

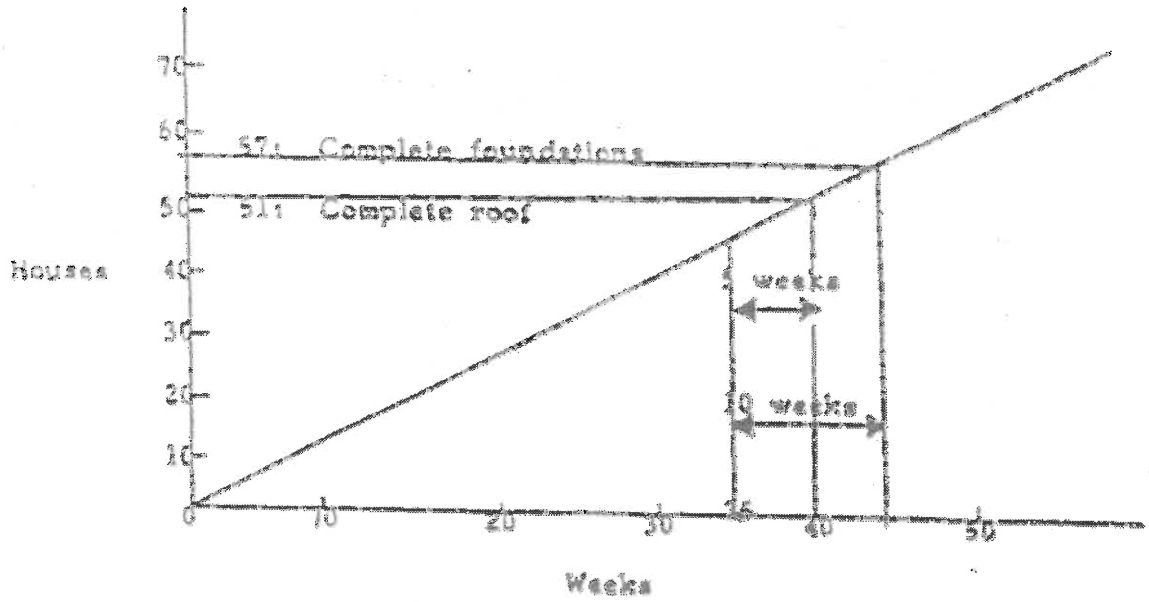


LINE OF BALANCE CHART AT A CERTAIN POINT IN TIME

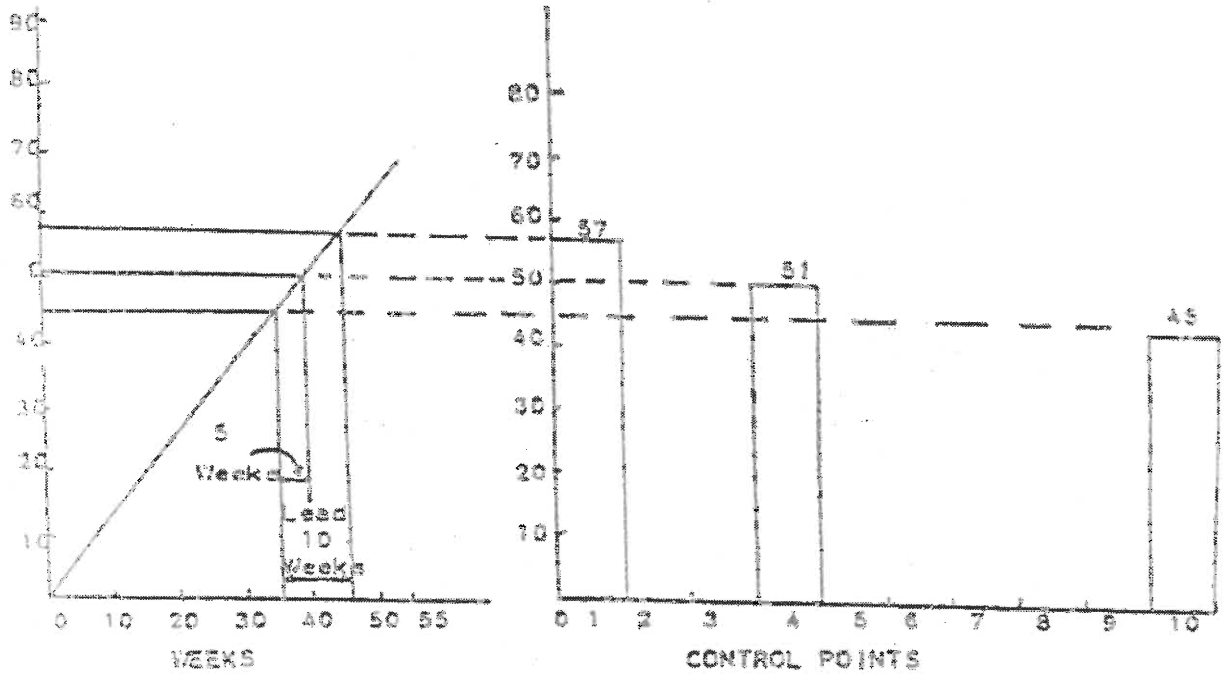
If we require the line of balance chart for example at week 35 in our example, we go to our graphs (on the previous pages) and for week no.35 we can read off the number of houses which should be completed in this instance + 35 houses:



If we now need to know how many foundation should be completed at this stage i.e. week 35 we must add the lead time for the foundations i.e. 10 weeks and then read off the number of foundation that should be completed in this case 57. If we take for instance



the number of roofs that should be completed at week 35, we again add the lead time for the roof, i.e. 5 weeks and then read off the number of roof that should be completed at week 35, in this case 51.

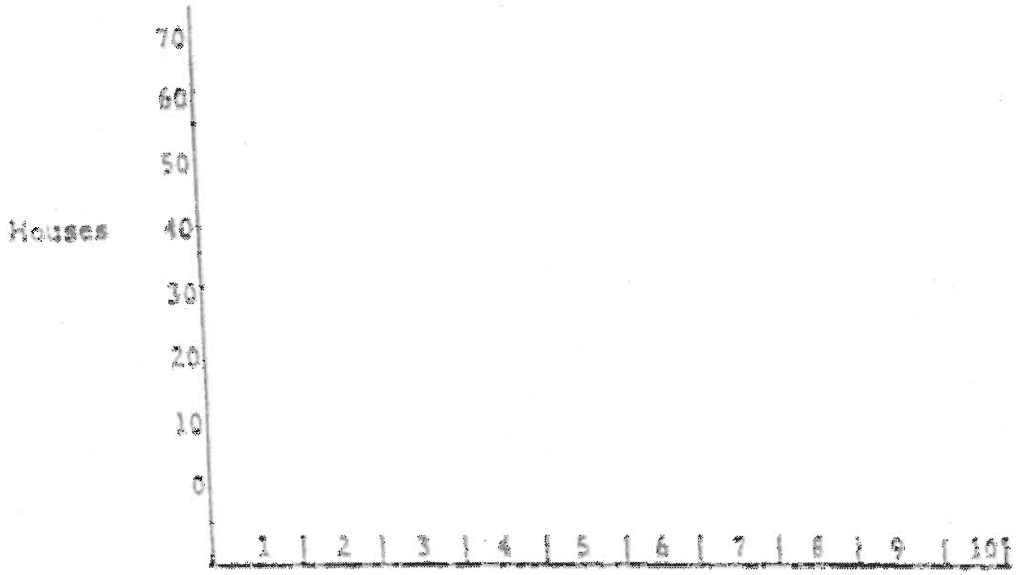


We can follow the same procedure for all the other points and determine on what number of units each activity is to be completed at week no.35.

If we don this we can draw the following line of balance progress chart at week 35. This chart indicates the estimated progress situation at that point in time.

EXERCISE

Complete the progress chart below



Line of balance chart for week 35

During the construction phase the actual progress can be determined on site at any point in time (e.g. week 35) and compared with the estimated progress. This comparison will show up nay deviations from the planned programme.

3. **LINE OF BALANCE – STEP-BY-STEP EXAMPLE FOR PLANNING A MULTIPLE HOUSE CONSTRUCTION PROJECT - EXAMPLE 2**

Line of balance chart for a project:

The next step is to draw a line of balance chart for the project (or a project). Let's assume the following:

A project consisting of 120 similar houses will require a handover rate of 6 houses per week. The contractor will be working a five-day week at 42 hours per week, and taking holidays etc., into account decides to base his programme on a total of 300 working days.

The sequence of activities will be as previously used and the estimated number of man-hours and gang sizes is given in the table below.

Operation	Man-hours per house M	Men per house H
Foundations	100	3
Brickwork	220	6
Window frames	50	1
Roof	200	4
Plumbing	150	3
Plaster	40	3
Joinery	120	4
Electrician	90	3
Decorates	130	4
Clean up	20	2

With this available information we are to draw up a Line of balance chart for the project.

Step 1

The first step is to calculate the total theoretical number of men – G- required to complete the required units per week – for each activity (Units per week – R). We have the following information: we require 6 units per week and u available 42 hours per week. Therefore we must complete 6/52 houses per week. Therefore we must complete 6/42 units per hour on each activity, but we have a certain given man-hours per house -M- which is required to complete that activity per house. From this: i.e.

$$G = Man-hours/house \times \frac{number\ of\ units\ require/week}{number\ of\ hours/week\ available}$$

= Theoretical gang size on the activity (theoretical number of men on the activity on the projects as a whole).

We calculate the number of labourers needed in our gang, and can write the formula:

Where G = theoretical gang size
M = man-hours/house

For example take the operation: foundations: according to the given table, 100 man-hours per house is required, thus M = 100.

Thus:

$$G = M \times {}^{6}/_{42}$$

$$= 14.29\ men$$

i.e. the gang size required is 14.29 men.

The same calculation can be made for the rest of the operations:

Operation	Man-hours per house M	Men per house H
Foundations	100	14.29
Brickwork	220	31.43
Window frames	50	7.14
Roof	200	28.57
Plumbing	150	21.43
Plaster	40	5.71
Joinery	120	17.14
Electrician	90	12.86
Decorates	130	18.57
Clean up	20	2.86

However, as it can be seen from the "G" column that the figure we have obtained is not rounded off and probably does not fit our gang sizes. (For instances it would be quite difficult to use 14.29 labourers, but will round it off to 14). In the rounding-off process we have to take into account our gang sizes – while 14 is a rounded-off figure it does not fit our gang size of 3 people per gang (H) i.e. we would require 4.67 gangs. Thus we have to round off our gang size -G- to 15 people which in turn will be gangs of labourers.

Rule: round off to the nearest multiple of H. (H = men per unit on the activity). This new gang size will be called "S" – the total actual no of men that will be placed on the activity (revised G).

Step 2

We then round-off all our gang sizes –G- off to the nearest full team to get S. Remember if S>G, the rate of delivery on that activity will increase, if S<G, the rate will be slowed down.

THE AIM MUST BE TO GET THE RATE ON ALL THE ACTIVITIES THE SAME (OR AS CLOSE AS POSSIBLE TO IT)

Operation	Man-hours per house M	Gangsize (men) G	Men per house H	Actual Gangsize S
Foundations	100	14.29	3	15
Brickwork	220	31.43	6	30
Window frames	50	7.14	1	6
Roof	200	28.57	4	28
Plumbing	150	21.43	3	21
Plaster				
Joinery				
Electrician				
Decorates				
Clean up				

EXERCISE

Complete the table above.

Because of the rounding-up or down process, production will not be quite at the same rate as if the gang sizes of "G' were adopted. (Where 6 houses per week was assumed). A revised rate of houses per week for each of the new or actual gangsizes "S" will have to be calculated.

Step 3

The next step is to calculate this revised rate of house productions – R_1 per week. If we say that R = original rate of production required i.e.6 houses per week.

And S = actual gangsize

And G = theoretical (or original) gangsize, we can write $R_1 = R \times \frac{S}{G}$

Thus for the operation of foundations it will be:

$$R_{1\ foundations} = R \times \frac{S}{G}$$

$$= 6 \times \frac{15}{14.29}$$

$$= 6.3\ houses/week$$

The same calculation can be done for all the other operations.

EXERCISE

Complete the table below.

Operation	Man-hours per house M	Gang size G	Men per house H	Actual Gang S	Revised rate of house production R_1 per week
Foundations	100	14.29	3	15	$6 \times \frac{15}{14.29} = 6.30$
Brickwork	220	31.43	6	30	$6 \times \frac{30}{31.43} = 5.73$
Window	50	7.14	1	6	$6 \times \frac{6}{7.14} = 5.04$
Roof	200	28.57	4	28	$6 \times \frac{28}{28.57} = 5.88$
Plumbing	150	21.43	5	21	$6 \times \frac{21}{21.43} = 5.88$

Step 4

We can now calculate the duration in working days for the completion of each activity on one housing unit.

For our example we firstly assume that the 42 working hours per week is spread equally over each working day, i.e. 42/5 = 8.4 hours per day.

Then we have:

Duration: $-D-=\frac{M}{H\times hours\ per\ day}$

i.e. *Duration* $-D-=\frac{man\ hours\ per\ house}{men\ per\ house\times per\ day}$

For the operation foundation we will have the following:

$$D=\frac{M}{H\times 8.4}$$

$$=\frac{100}{3\times 8.4}$$

$$=3.97\ days$$

i.e. the foundation for one house will be completed in 3.97 days.

This figure can be rounded off to the nearest full value which will be 4 days. Normally this rounding-up or down will not affect the calculations in any ways, except for the fact that we can plot our chart more easily, and therefore no adjustments will be necessary.

We now can do this calculation for all the other operations:

Operation	Man-hours per house M	Men per house H	Time for one house D
			$D = \frac{M}{H \times 8.4}$
Foundations	100	3	3.97 (4)
Brickwork	220	6	4.37 (5)
Window frames	50	1	5.95 (6)
Roof	200	4	5.95 (6)
Plumbing	150	3	5.95 (6)

Exercise

Complete the table above.

Step 5

The last calculation to be made is that of the time required to complete an activity on all of the required units. For the purpose of plotting our Line-of-balance chart, we need to know what is the time difference between the start of the first unit and the start of the last unit. (On the other hand – the finish of the first unit and the finish of the last unit). If N is the number of units, the time difference will therefore span a duration of N –1 construction periods. The time for each activity over all the units, T, is then:

$$T = \frac{Construction\ periods \times working\ days/week}{Actual\ rate\ of\ output\ per\ week}$$

$$T = \frac{(N-1)}{R}$$

For the foundation operation we can now calculate the total duration (in working days).

$$T = \frac{(N-1) \times 5}{R}$$

$$= \frac{(20-1) \times 5}{6.3}$$

$= 94.44\ days$ the time lapse between the start of foundations (the activity) on the first unit and the start of foundations on the last unit.

Once again we calculate the total duration for all of the operations.

Exercise

Complete the table below:

Operation	Man-hours per house M	Men per house H	Total time for operation T- days
			$t = \frac{(N-1)\times 5}{R_1}$
Foundations	6.3	4	94.44 (95)
Brickwork	5.73	5	103.84 (104)
Windows and frames	5.04	6	118.06 (118)
Roof	5.88	6	101.19 (112)
Plumbing	5.88	6	101.19 (102)

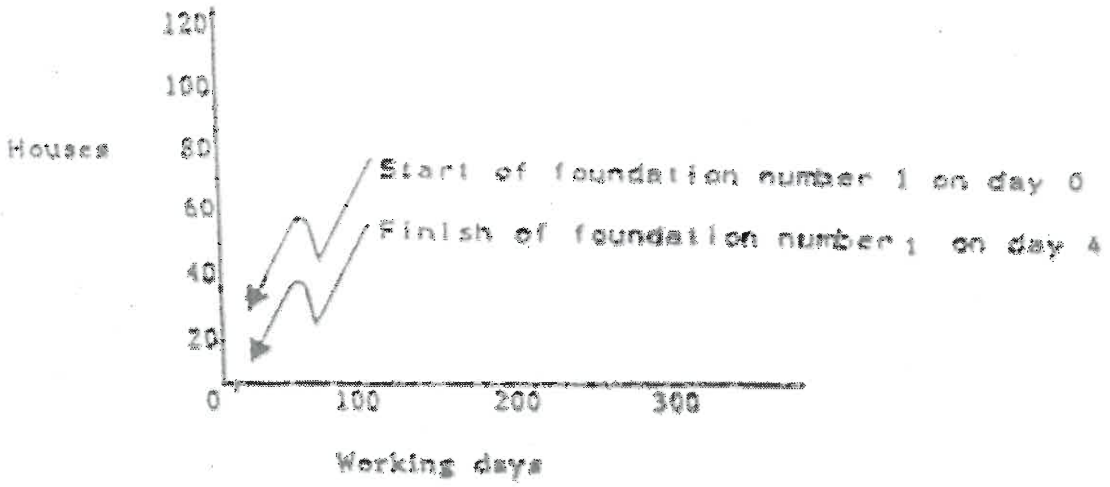
Again we round off this figure.

We now have enough information to enable us to produce a programme chart. To explain the principle of the line-of-balance-chart it will be assumed, initially, that each of the activities will be sequential rather than having some overlapping (parallel) activities as in the diagrams for the unit of housing.

We plot the following:

(a) the number of houses on the vertical axis and
(b) the number of working days on the horizontal axis

The first operation is that of foundations: since this is our first operation we assume we will start day 0. According to our table, the duration necessary to complete one operation or one foundation is 4 days. We then plot this information in our chart:

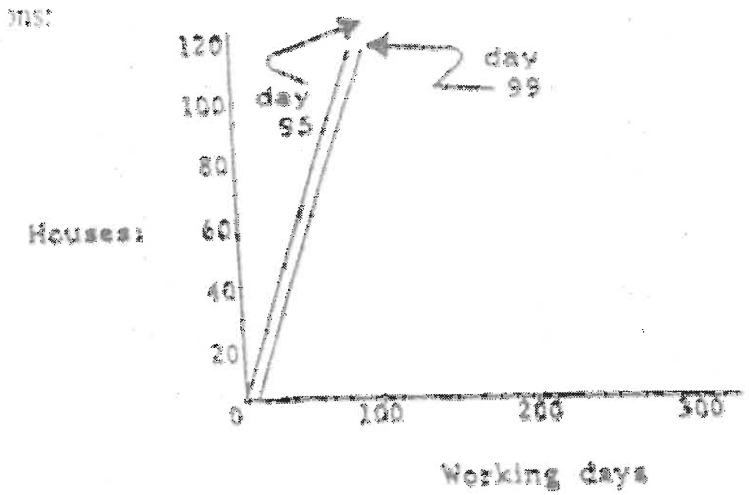


From our table we now get the value for T- the total time for the activity.

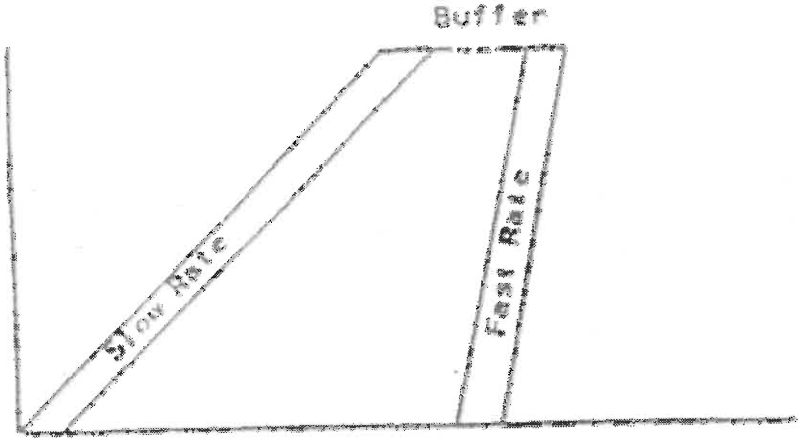
Thus for the foundations we have a time of 95 days calculated. The meaning of this 95 days is the following, that from the start of the first unit, to the start of the last unit, it will take use 95 days: so for our foundations we can plot the following:

Start of activity	= day 0
Completion of 1st unit	= day 4 (= day (4+0)
Start of last activity	= day 95
Completion of last activity	= day (95+4) = day 99

And we can then join these points to give us the line of balance for the operation of foundations:



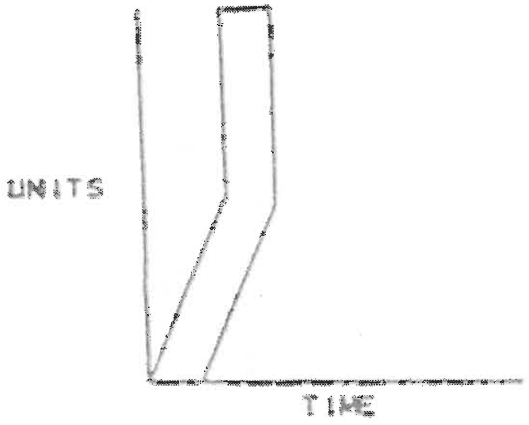
Similar bands can be constructed for all of the operations. It should be noted that it is generally impractical to commence the next operation immediately after the completion of the one before. A "time buffer" is often needed between them. When succeeding activities are completed at a faster rate than its predecessors, then the bands on the line-of-balance chart will close towards the top. The buffer time between the activities must then be provided at the top. (When given a problem this "buffer line' will be specified, else a time must be assumed).



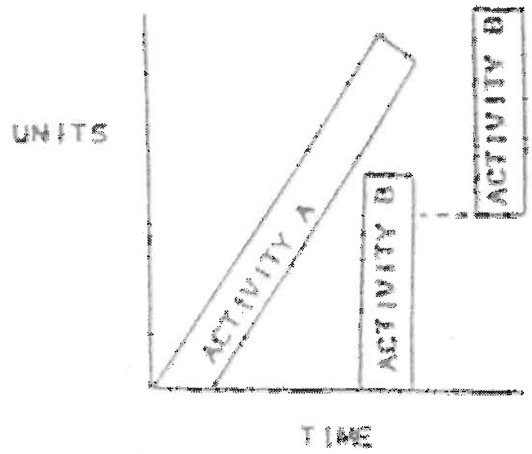
Exercise

Draw the situation when the buffer will have to be provided at the bottom in the line-of-balance chart.

The bands need to always consist of two parallel straight lines. It may be desirable to change the resources allocated to any one operation during the course of the project. The slope of the band will then change at this point. An increase in resources can for example have the following effect on the line.



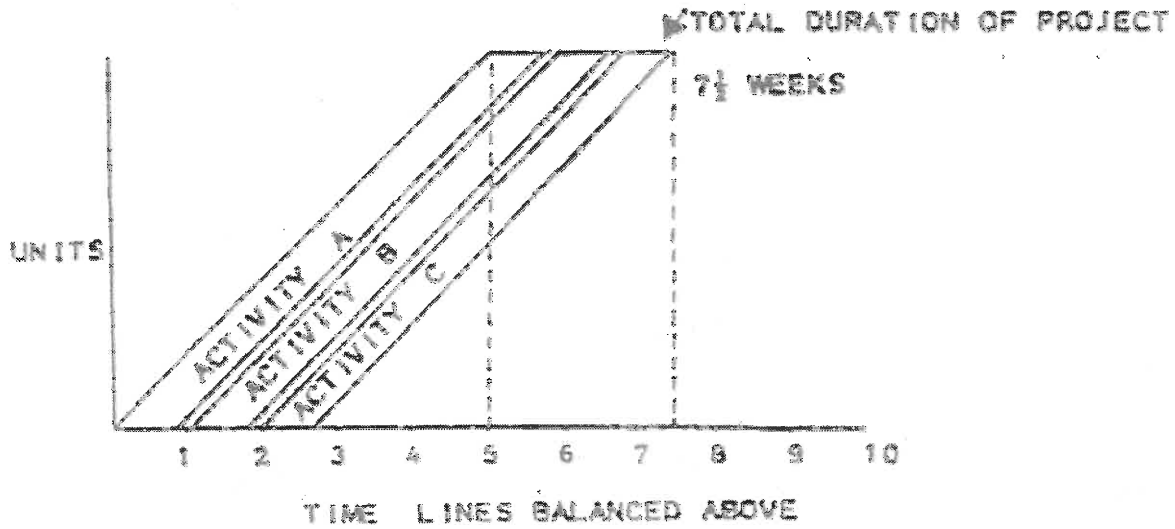
In order to balance activities the lines can also be broken.

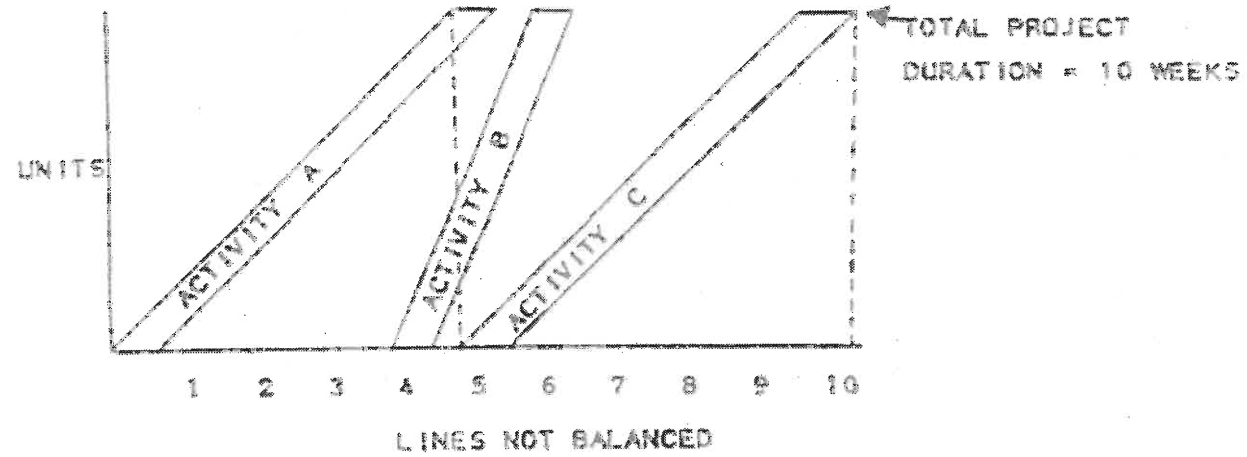


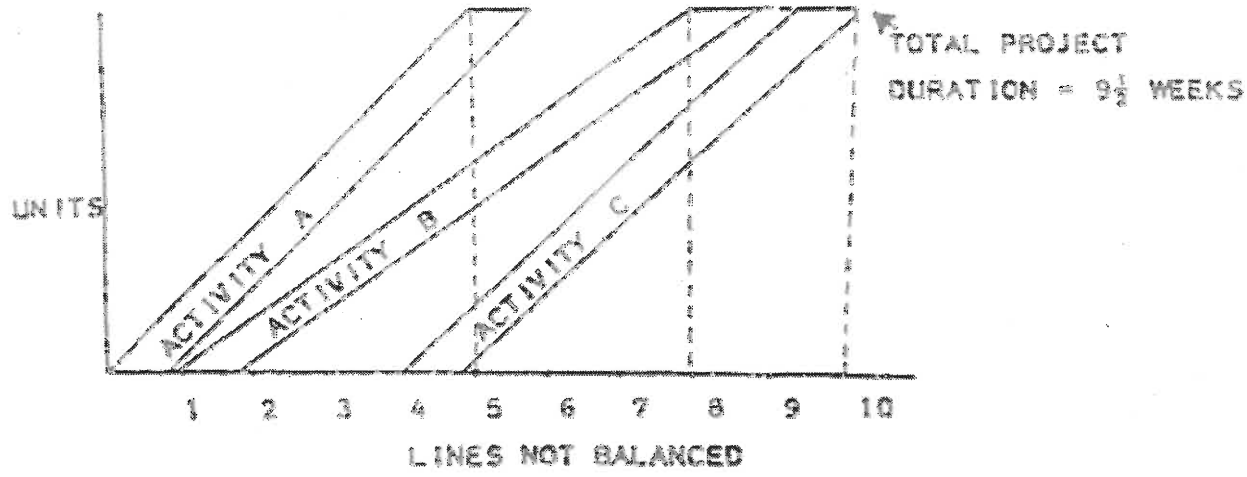
Can you explain to yourself when this will become necessary?

Note

When lines are not balanced, the total project duration is increased.



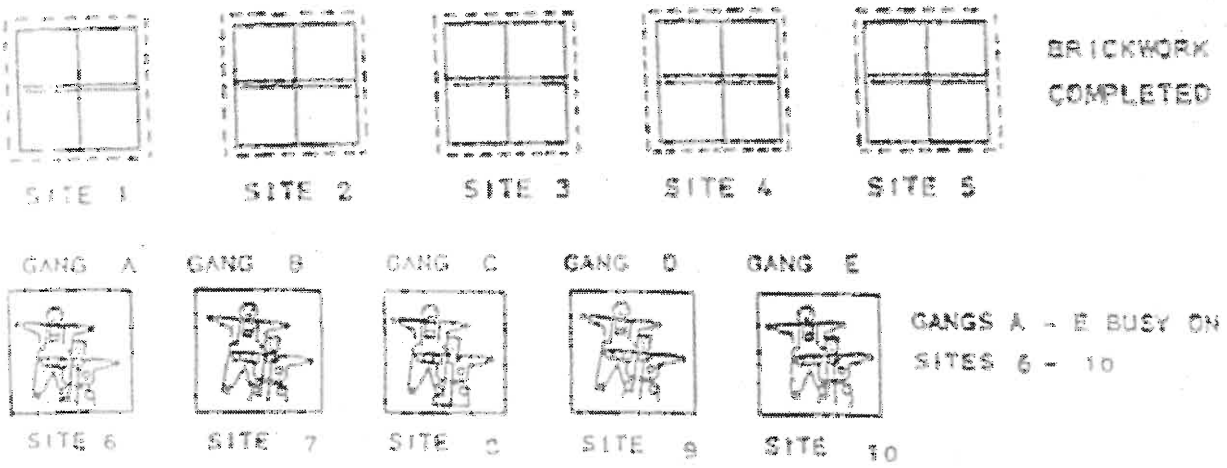




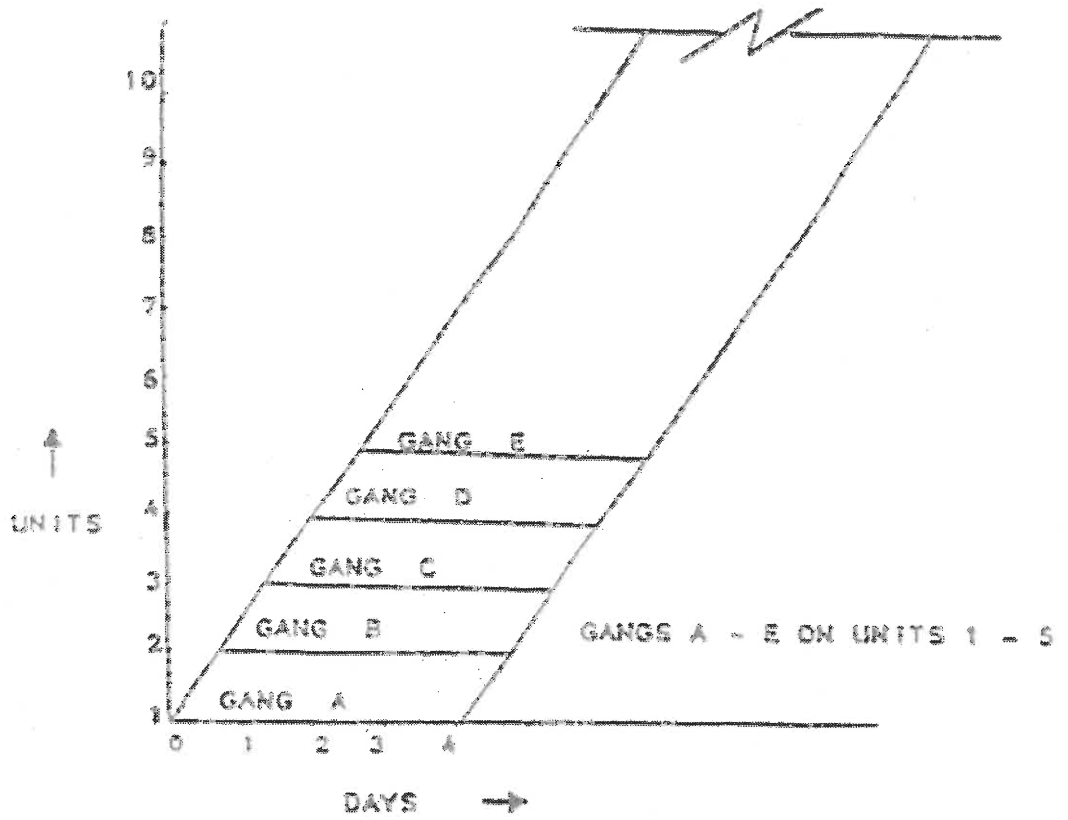
GANG MOVEMENTS

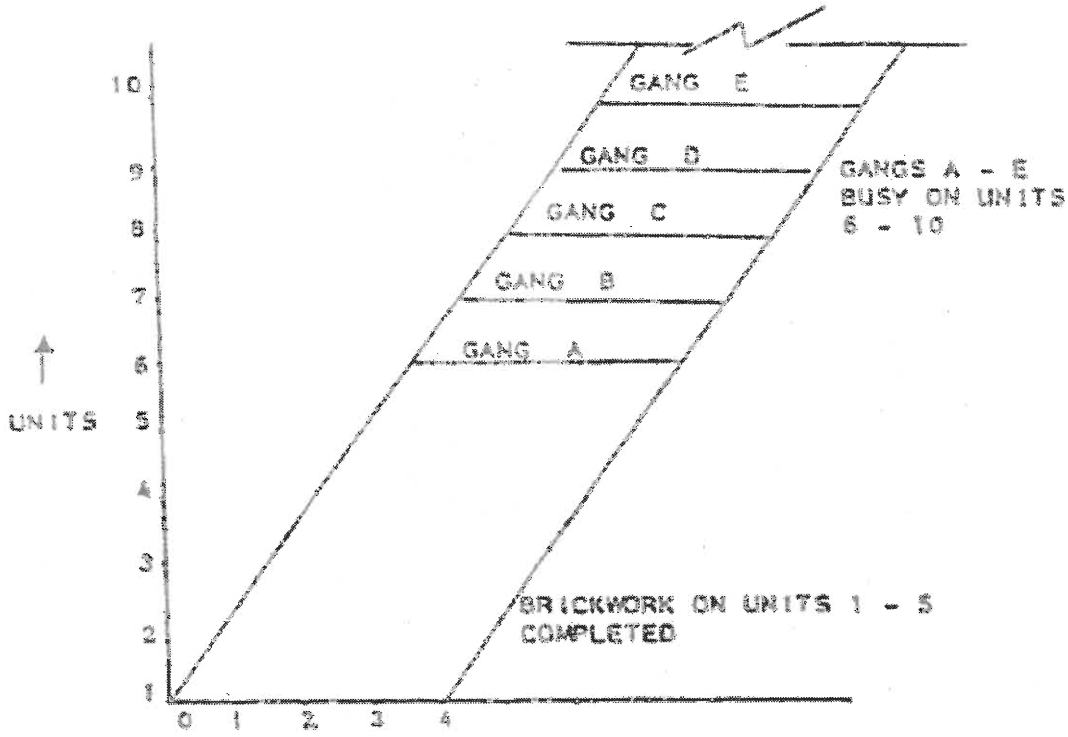
Picturise the situation where 30 men are employed on brickwork(s) which comprise of five six-men-gangs 9G-6) this is the situation we have on the brickwork activity on our project. Number the gangs a, b, c, d, and e. They will all start at the same time on unit numbers 1, 2, 3 , 4 and 5 respectively.

When the brickwork is completed on these units, they will move over to unit numbers 6 to 10.

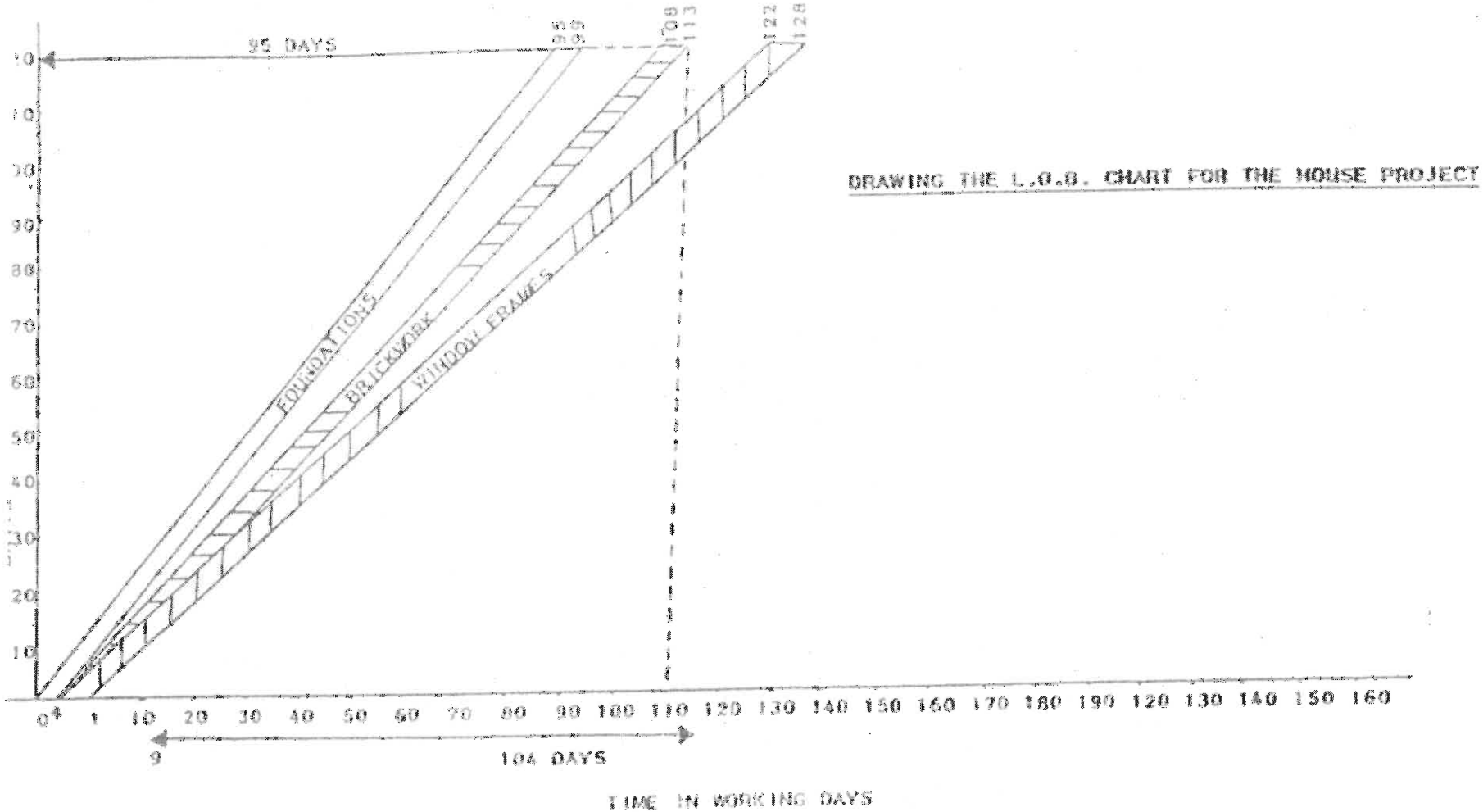


This process will repeat itself until the activity is completed on all the units. The same sequence will occur on all the activities. This process can be pictured in graph form on the L.O.B. chart as follows:





DRAWING THE L.O.B. CHART FOR THE HOUSE PROJECT



DRAWING THE L.O.B. CHART FOR THE HOUSE PROJECT

NOTE: Slower rate - flatter slope - start from bottom and add T
Faster rate - steeper slope - start at top and deduct T
Parallel activities will overlap.

EXERCISE: Re-do the above on graph paper and complete the L.O.B. Chart.

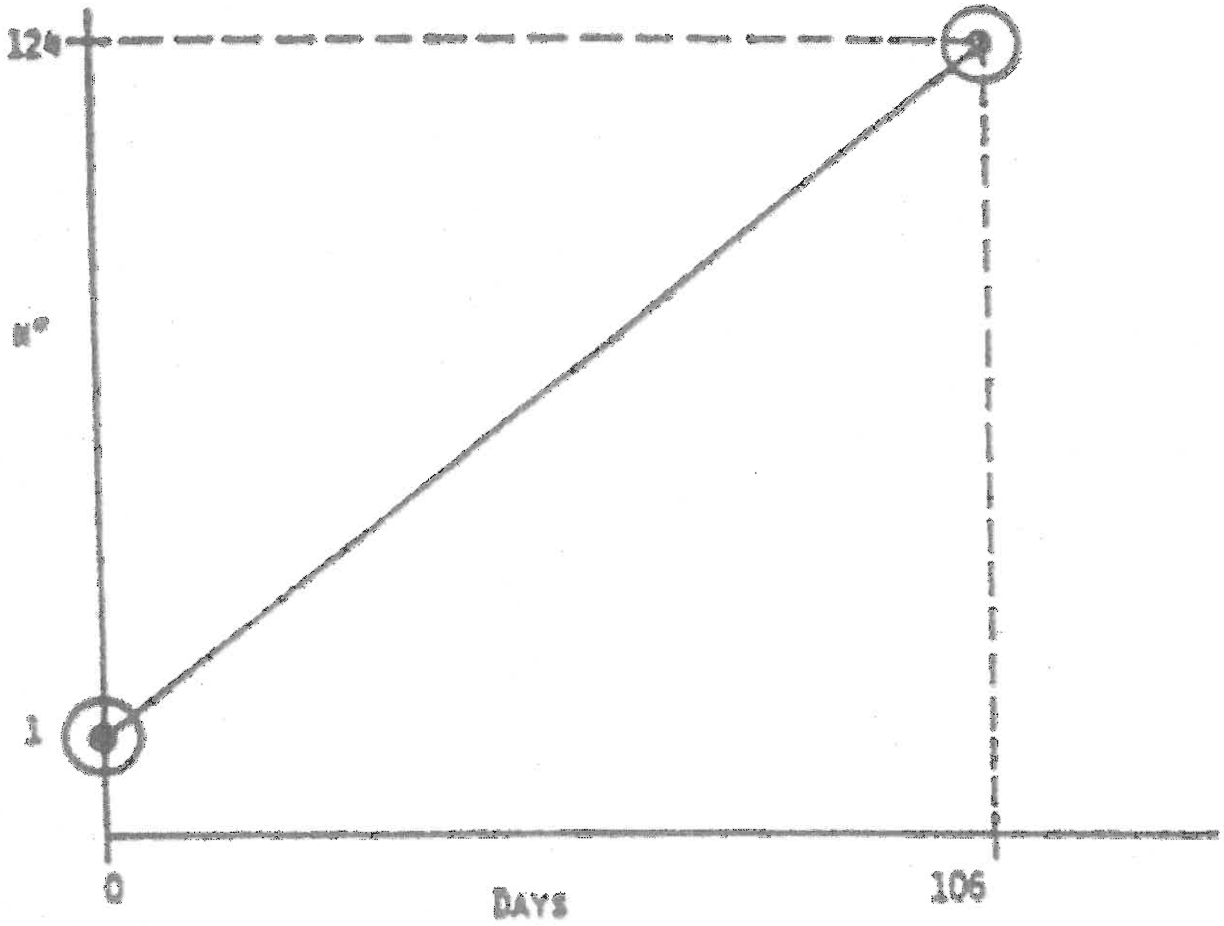
PLOTTING THE GRAPH

STEP TO FOLLOW

Activity "A" start day 0.

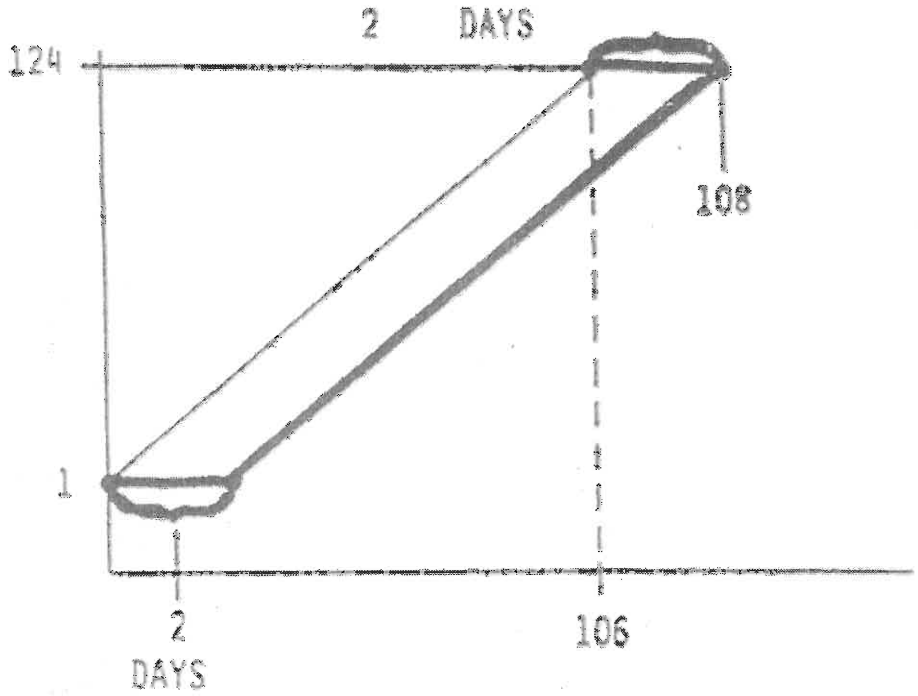
The last substructure is started 106 days later

∴ 0+ 106



From Column 7:

Time for "A" =

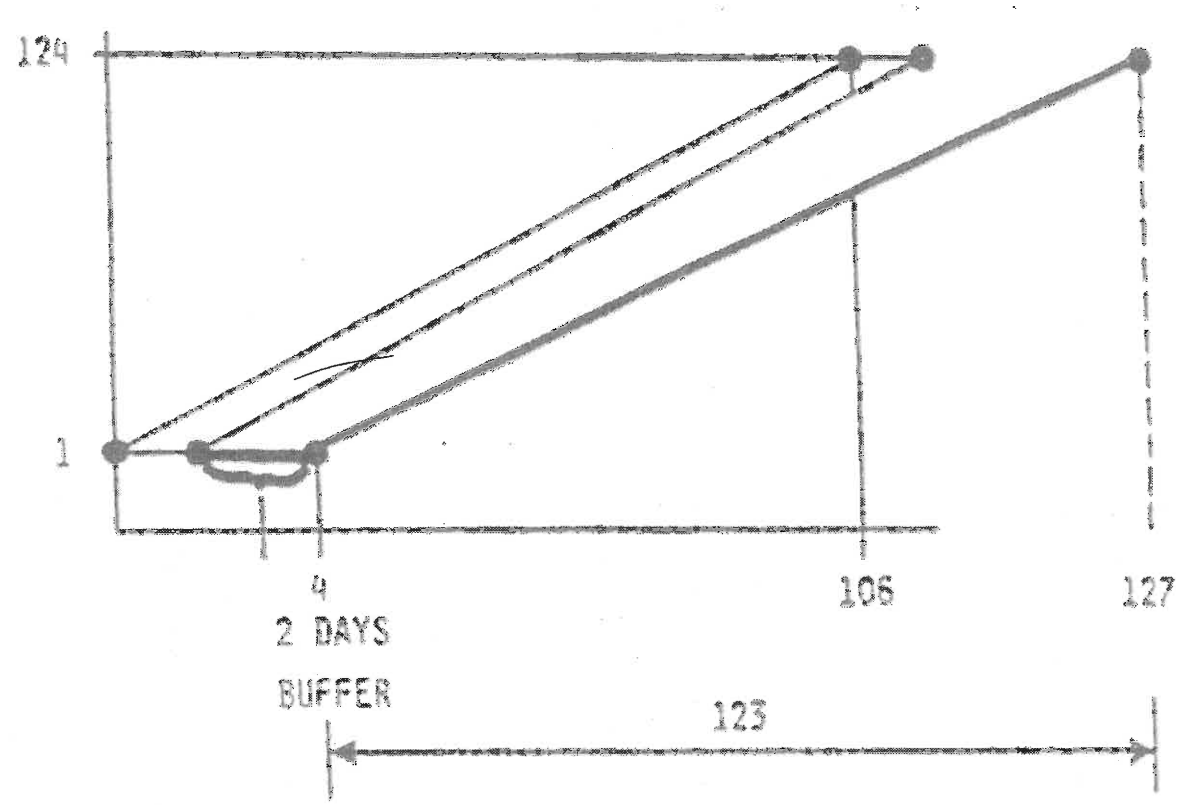


SUBSEQUENT ACTIVITIES:

STEP 1 :

- Look at rate of activity B
- If faster than "A" (Previous one) then allow buffer at top.
- If slower rate (Smaller figure) allow buffer at bottom.

2 + 2 = 4

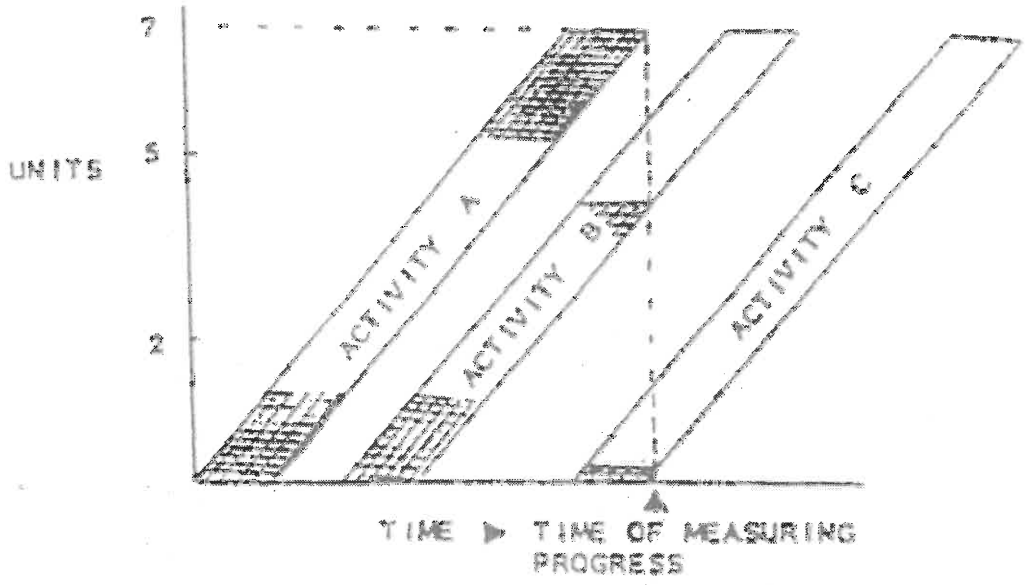


For activity B 123 days between start on first foundation and start on last foundation
∴ 4 + 123 = 127

The rest follows the same pattern.

PROGRESS CONTROL

During the construction phase, progress can also be monitored by means of this chart.



At the time of measuring progress in the example above, activity A must be completed on al 7 of the units (100% completed) activity B must have been completed on 5 units and activity C must have been completed on 2 of the units. This progress can be compared with the physical progress on site to check whether progress is according to the planned programme.

SUMMARY OF STEPS IN CALCULATING DATA FOR A L.O.B. CHART

STEP 1

Calculate theoretical gangsize "G"

$$G = \frac{R}{Number\ of\ hours\ available/\ week \times M}$$

STEP 2

Round off G to the nearest multiple of H to determine S.

STEP 3

Calculate revised output rate.

$$1 = R \times \frac{S}{G}$$

STEP 4

Calculate duration for activity to be completed on one unit in days.

$$D = \frac{M}{H \times hour/day}$$ and rounded off

STEP 5

Calculate the time that lapses between the start on the first unit and the start on the last unit for each activity.

$$T = \frac{(N-1) \times number\ of\ working days/week}{R_1}$$

STEP 6

Plot the chart using the network, T, buffer times and R_1.

SUMMARY OF SYMBOLS AND FORMULAE

E = Earliest starting date at control point

M = Man-hours per unit for each activity separately

H = Men per unit for each activity separately

G = Total theoretical number of men on each activity on the project as a whole

S = Revised G (rounded off to multiples of H)

R = Target rate of build (theoretical)

R_1 = Revised date of build

D = Duration for each activity on one unit only in days

T = Time lapse between start on first unit and start on last unit for each activity separately

$$G = \frac{M \times R}{Number\ of\ hours/week}$$

$$R_1 = R \times \frac{S}{G}$$

$$D = \frac{M}{H \times hour/day}$$

$$T = \frac{(N-1) \times 5}{D}$$

ADVANTAGE OF LINE OF BALANCE TECHNIQUES

1. Vividly displays the rate of working of one trade against another.

2. Related the requirements of specified resources to the achievement of a planned completion date.

3. Embraces the optimum deployment of resources when these are in different gang on different repetitive tasks but all contributing to an output.

4. Out of sequence working between related and unbalanced manning are eliminated by the exercise of the technique in establishing output targets.

5. Schedules may be prepared from the chart as an aid to progressing materials deliveries.

6. These schedules clearly indicate the number of units to be completed by a specific date.

7. The principles of the planning system are readily understood at site management level. The schedule is easily updated. Actual performance can be compared with the planned requirements at any date.

8. Regular progress recording highlights the need for increased gang requirements in order to enable the recovery of any lost time.

DISADVANTAGE OF LINE OF BALANCE TECHNIQUES

1. Only applicable to repetitive forms of construction, e.g. houses and flats.

2. Summarizes many considerations, thus short of detail and hence explanation.

PROBLEM

Problem 1 (Must be handed in)

Your company has been awarded a contract to erect 124 pylons for the electricity board:

Operation	Man-hours per operation	Optimum number of men
A. Excavate	55	4
B. Concrete found	64	4
C. Erect tower	145	8
D. Fix conlilever beam	90	8
E. Fix invalators	25	5

The table above shows the sequential operations involved in the construction of each pylon together with the estimated man-hours and optimum number for each operation.

The handover rate specified is 6 pylons per week and this can be taken as the target rate of building.

Prepare a line of balance schedule assuming that each gang works at its normal rate. State clearly the contract duration. Assume a five-day working week, eight hours per day, and a minimum buffer of two days between all activities.

Provide your answer on the table overleaf.

ADDENDUM B

LINE OF BALANCE CALCULATIONS

ACTIVITY	MANHOURS PER UNIT M	MEN PER UNIT H	TOTAL NO. OF MEN ON ACTIVITY "G" $G = \frac{M \times R}{HRS/WEEK}$	REVISED G MULTIPLES OF H = "S"

REVISED RATE OF BUILD $R^n = \frac{R \times S}{G}$	DURATION ON ONE UNIT IN DAYS "D" $D = \frac{M}{H \times HRS/DAY}$	TOTAL TIME LAPSE $T = \frac{(N-1) \times 5}{R^n}$	T ROUNDED OFF

Nelson Mandela Metropolitan University

for tomorrow

DEPARTMENT OF BUILDING AND QUANTITY SURVEYING

CONSTRUCTION MANAGEMENT III
DCO3010

CHAPTER 4
BUDGETING

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P M NOTES NO: 6A

BUDGETING

GOAL 1
To understand the object and necessity of Budgets in a Building Firm

Objective 1
Define a Budget

Objective 2
Describe the functions of a Budget

Objective 3
Describe the objectives of Budgets and why they are necessary

Objective 4
Describe each of the following Budgets and explain how they are drawn up.

Operating Budget
Financial Budget
Overheads Budget
Subsidiary Budgets such as:
- Sales Budget
- Labour Budget
- Plant Budget
- Debtors Budget

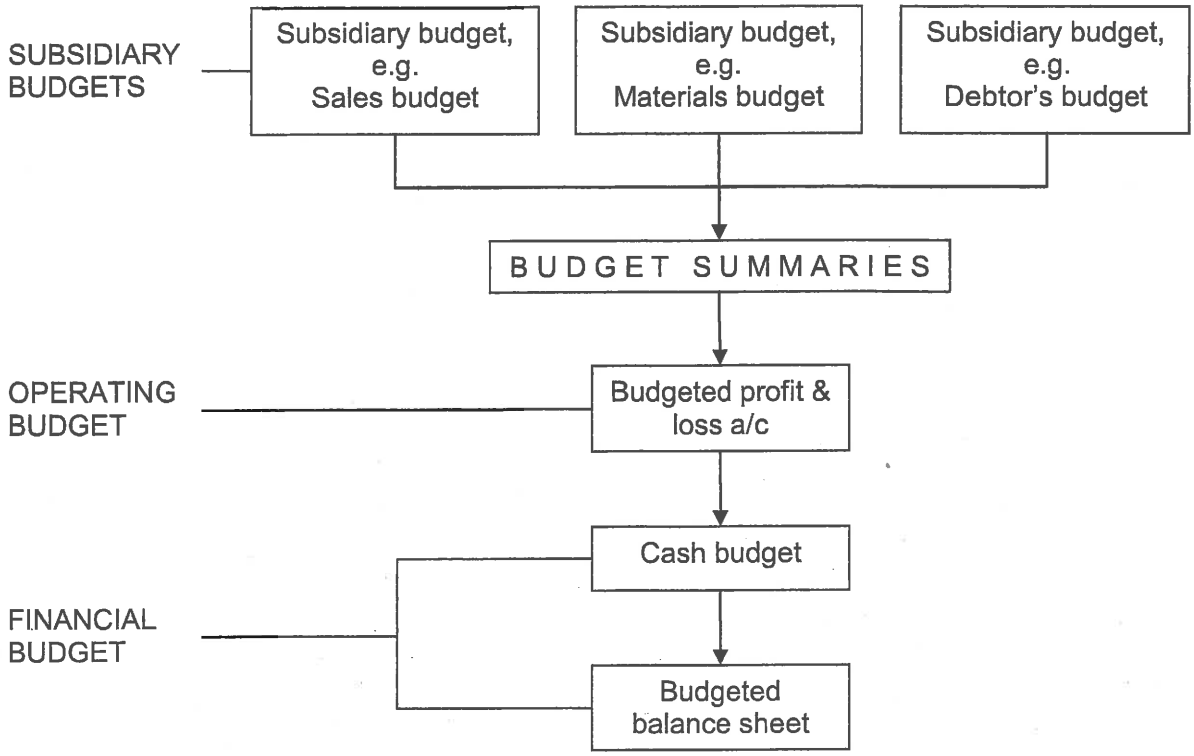


Figure 1 - Flow chart – master budget

GOAL 1

Objective 1

A Budget is a formal, quantitative and detailed plan which will be used as a guideline, a standard or a means of control over future activities by management to enable them to control future events.

In a Building Firm various types of Budgets are used, - see flow chart.

Objective 2

The function of a Budget is to check the output and observe overall costs. This can be on a time basis to compare the estimated time against the actual. This is usually done in a graph from where the cost of all labour, material, plant, overheads, etc. is compared with the contract duration.

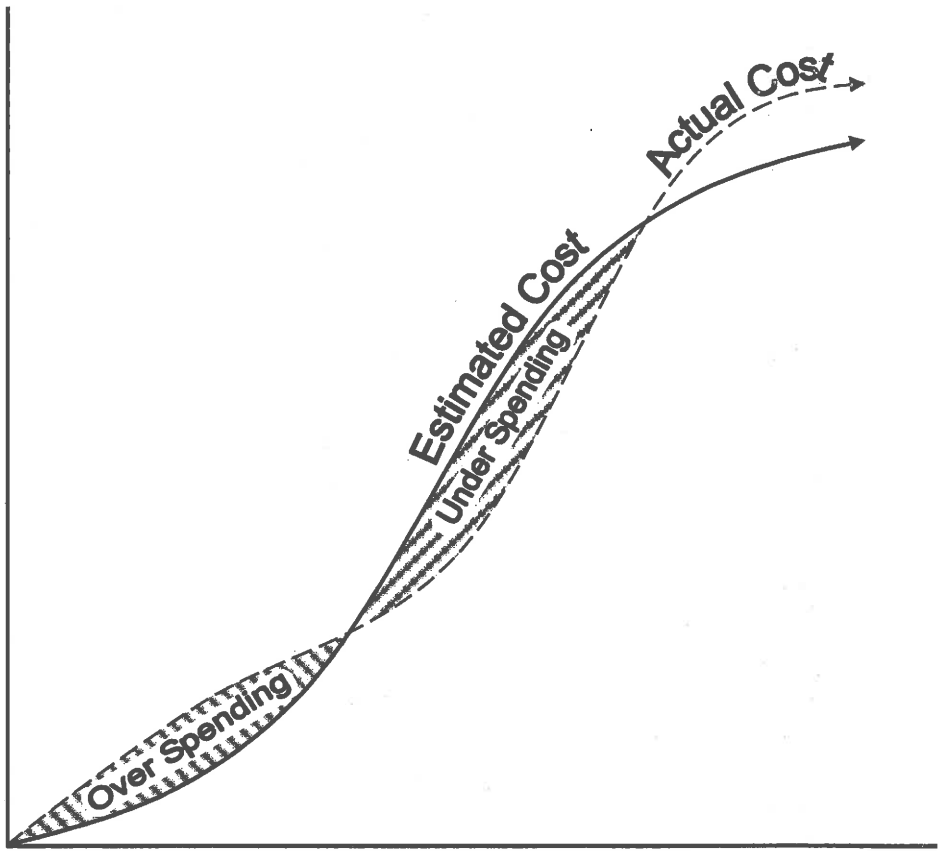


Figure 2 – Cost Graph

The reason for checking is to prevent the loss of money due to poor output or lack of supervision. The profit conscious owner of a company it is important to know, out any stage of the contract, how it is progressing financially and time wise because delays cost time and time costs money.

The graph as anticipated is calculated from pre-planned programmes using info available at the time on drawings, specification and B of Q (if any).

Exercise in Budgets

Consider a contract of R800 000 over 20 months where

Labour amounts to	300 000
Material	340 000
P & G	10 000
Overheads	15 000
Sub Contractors	118 000
Contingencies	10 000
Profit	7 000
	800 000

a) Overheads Budget normally consists of fixed charges and variable charges. Assume 1/3 of the variable overheads is spent in the firs 4 months and 1/3 in the next 6 months and the remainder over the last 10 months. If the ratio of fixed overheads to variable overheads is 40 to 60%, then we have: of the variable overheads is spent in the first 4 months and 1/3 in the next 6 months and the remainder over the last 10 months. If the ratio of fixed overheads to variable overheads is 40 to 60%, the we have:

Month	1 – 4	300 + 750	=	1050 per month
	5 – 10	300 + 500	=	800 per month
	11 – 20	300 + 300	=	600 per month

Objective 3

In order to ascertain direction in which to move and control expenses and losses during actual performance of work. Budgets must be flexible to accommodate changes in conditions. The effect of the changes on predetermined figures must be considered.

Objective 4

Operating Budget

The amount of work that any firm can handle depends on its resources, i.e. size of firm, labour force, availability of labour and supervisory staff, and plant at his disposal and capital reserves of the firm. Only the managing director will decide if workload can be increased or decreased and it is up to him/her to budget for future work. The flow of work is controlled by an Operating Budget which will show the extent of work in hand and the amount of new work that can be entered into.

Example amounts in 10 thousand rand. (Value of Work)

	1984				1985				1986				1987			
Contracts	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Housing	4	4	4	4	4	4	4	4	4							
Shopping Centre	3	3	4	5	5	2										
Flats		2	3	5	7	7	6	8	5	3	2					
Factory					5	5	7	6	4							
School	11	9	6						13	3	2					

Financial Budget

This is drawn up from information provided by the labour, material and overhead budgets and shows the funds or money that will be required during certain production periods. This will ensure that allowance an be made for funds to meet the anticipated expenditure. It will also show the amount of income required to be able to finance the work.

FINANCIAL BUDGET

ITEMS	1st QRTR	2nd QRTR	3rd QRTR	4th QRTR	TOTAL
Op. Balance	8 000	5 900	-3 150	2 950	13 700
Receipts			25 950		
Sales	6 000	8 100	1 000	15 550	55 600
Retention	1 000	450	-	1 000	2 700
Sale of Plant	500	-		-	500
	15 500	14 450	23 050	19 500	72 500
Payments	2 500	10 000	9 500	3 200	25 200
Wages	1 500	4 000	3 500	1 600	10 600
Mat. Cred.	2 700	2 700	2 700	2 700	10 800
O/H	900	900	9 00	900	3 600
Admin.	-	-	2 000	-	2 000
Plant Purch.	1 000	-	-	-	1 000
Taxes	1 000	-	1 500	-	2 500
Dividends	9 600	17 600	20 100	8 400	55 700
Balance C/F	5 900	- 3 150	2 950	11 100	16 800

The profit target will be set or the limit of loss that the company can enter into. Another aspect of the financial budget is to control profits so that the company can show a regular rate of profit and not a fluctuating profit from year to year where large profits can be consumed by taxes and small profits in another year will upset shareholders.

Overheads Budget will regulate the charges in respect to overheads relative to production. It will help to control the allocation of overheads to contracts so that tenders are not lost as a result of too large apportioning of overheads. Overheads are usually divided into two categories:

1. Fixed charges which will remain constant during a certain range of production.

2. Variable charges which change according to the output.

   E.g.: A contract over 12 months has R10 000 overheads of which 60% is fixed and 40% is variable. The variable overheads are required as follows:

   50 % over the first 5 months
   25% over the following 3 months
   25 % over the last 4 months

Month	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
Fixed	500	500	500	500	500	500	500	500	500	500	500	500	6 000
Variable	400	400	400	400	333	333	333	250	250	250	250	250	4 000
Total	900	900	900	900	900	833	833	833	750	750	750	750	10 000

Sales Budget

This covers the value of work to be done and for which payments wil be received at specified time intervals, (e.g. quarterly or monthly).

BUILDING DEPARTMENTS					
Period	Contracts	Small Works	Steel Yard	Joinery	Total
1st Quart	100 000	30 000	3 000	6 000	139 000
2nd Quart	140 000	35 000	3 500	5 000	183 500
3rd Quart	115 000	40 000	3 000	5 500	163 500
4th Quart	90 000	32 000	2 500	4 500	129 000
Budget Total	445 000	137 000	12 000	21 000	615 000
Current	405 000	130 000	11 000	20 000	566 000
Difference	40 000	7 000	1 000	1 000	49 000

Material Budget

This is drawn up to make provision for the timeous purchase and delivery of materials, bearing in mind the quantity, date required and credit periods. It is usually done together with the labour budget in the form of a bar chart or material schedule.

Labour Budget

This is used for the distribution of labour to the various contracts to ascertain when certain trades will be required and how many of each, when they can be transferred to other contracts and to find out whether additional labour should be employed.

EXAMPLE

Consider a contract where labour and material is divided into the trades as follows over 10 months on a contract.

Total value of own work is R226 000.

Trade	% Labour	Amount	% Material	Amount	Total
Excavator	100	30 000	0	0	30 000
Concrete and Formwork	40	36 000	60	54 000	90 000
Bricklaying	55	37 400	45	36 600	68 000
Carpentry	25	6 000	75	18 000	24 000
Flooring	50	17 000	50	17 000	34 000
Plastering	35	7 000	65	13 000	20 000
		134 000		132 000	266 000

Plant Budget

This is drawn up to phase items of plant into the requirements of the various contracts. This will entail allocating items of plant for specific jobs. Any plant not used regularly will immediately show up and a decision can be made whether to keep such an item and not getting revenue from it or to sell and hire such plant when required.

Any shortage of plant will be highlighted and decision has to be taken regarding the purchase of additional plant to compensate for the shortage.

Budget Schedule

TRADE	MONTHS									
	1	2	3	4	5	6	7	8	9	10
Labour	20	10								
EXCAVATOR	20	10								
Materials										
Labour	4	16	16							
CONCR. & FMWK.	10	40	40							
Materials	6	24	24							
Labour			4.4	11	11	11				
BRICKLAYING			8	20	20	20				
Materials			3.6	9	9	9				
Labour						2	2	2		
CARPENTRY						8	8	8		
Materials						6	6	6		
Labour				1					8	8
FLOORING				2					16	16
Materials				1					8	8
Labour							1.75	1.75	1.75	1.75
PLASTERING							5	5	5	5
Materials							3.25	3.25	3.25	3.25
TOTAL	30	50	48	22	20	28	13	13	21	21
LABOUR	24	26	16	12	11	13	3.75	3.75	9.75	9.75
MATERIAL	6	24	24	10	9	15	9.25	9.25	11.25	11.25

NB: All Figures shown to the nearest 1000

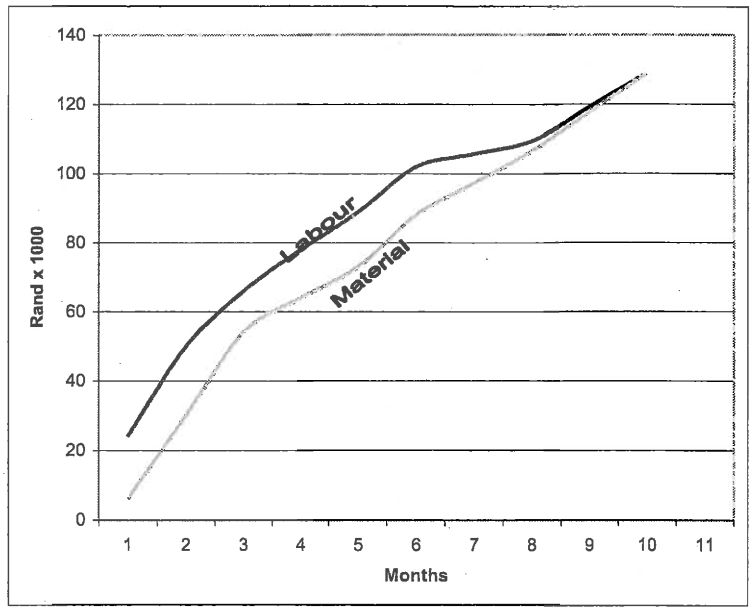


Figure 3 – Budget Schedule with Budget Graph

Debtors' Budget

To operate a contracting firm, the cash flow becomes an important factor. Money is paid continuously and to replace such money it is necessary to have a look at income. The Contractor's source of income is the client or debtor and to ensure progressive operation of the firm it will be important to know what money is coming in and when.

The debtors' budget will thus show who the debtors are and when money (and amount) is due. This is taken from budgets of value of work done on each contract and all contracts to show the probable amount that should be received each month.

GOAL 2

Objective 1
Describe insight into the effects of money on a Building Firm.

Objective 2
Define money giving of annual turnover and output on the cash situation of the Firm.

Objective 3
Describe interest on money and the benefits to the firm.

Objective 4
Describe the money/time relationship and its effect on a business.

GOAL 2

Objective 1

Any Building Firm relies on production to stimulate income. The more work produced the higher the income the greater the turnover. It is therefore evident that output affects turnover and turnover is the amount of money earned by the firm. From this follows that the higher the output the more money will be earned which could be used for expanding the scope of the firm and being able to enter into more work in the future, which again will lead to bigger turnover and more cash to finance new projects.

Production and output will also result in bigger profits, because the increase in turnover should bring in more profit if the same profit margin is applied and this will increase the money (cash) resources which can be used for more work.

Objective 2

Money is any medium of exchange that is generally acceptable as payment for goods, services, debts and taxes. In modern times money is universally in the form of government metallic coins and bank notes (paper money). Cheques and promissory notes are also regarded as money.

The cost of money depends on the strength of its backing, because the note or coin does not have any real value but the backing, in our country gold, does give it a value which is acceptable to all users.

The primary function of money is to serve as a medium of exchange and thereby avoiding cumbersome and time – consuming barter transactions.

As seen in previous notes, production enhances the amount of money received. Production is also relative to the cost of money, because the amount of production against the same value of money will raise the value of money. A person laying 1 000 bricks a day gives much more value for his wages as the person laying 500 bricks per day even if there is a slight difference in pay. Assume a bricklayer earns R6 per hour, and lays 1 000 bricks per day and another earns R5, and lays 500 bricks per day. The cost of laying one brick in the first case is R0,48 while in the second case it would be R0,96.

From this it can be seen that higher production tends to make an article cost less and the cheaper the article the higher the value of money.

Objective 3

Interest is the reward for capital. Anybody investing money expects a return (reward) for his money invested or Loan. This reward will act as a compensation for allowing the other party to use his money.

Discounts are also regarded as interest which is paid to secure cash resources and is therefore considered as pure financial matter.

Consider a firm has a debtor, but he requires cash urgently to run his business. The firm can either borrow money by bank overdraft or try and entice the debtor to pay early. By giving the debtor 5% discount if paid within 7 days the contractor is rewarding him for letting the contractor use his money. This will result in better cash flow for the firm and enabling him to enter into more work at an earlier stage.

Interest is linked with the availability of money and if money is plentiful the interest rate will drop while scarcity of money will cause interest to rise.

Objective 4

Money is paid to employee for the use of their time and similarly the employee is prepared to give his time to the employer in return for money. Money is therefore closely linked with time because time costs money. Time wasted on sites by employee will increase the cost of the work and also the time taken to perform certain tasks will increase the amount tendered causing the work to be more expensive.

Completion time has a big effect on the profit because a job finished ahead of the planned time will save the contractor money in respect of salaries which will not be paid and resources which can be utilized elsewhere, while the reverse will be the effect if the work is finished late and site staff, workmen, plant etc. has to be paid for a larger period than anticipated.

Time of completion can also affect the penalties that must be paid by the contractor and this extra time cost a lot of money.

Workmen are usually prepared to work longer hours but at extra payment (overtime pay), which is another example of the cost of time.

In every day life we find that the parties involved in employment (employer & employee) will strive towards the best bargain and try to get the best value. The employer expects maximum output for the wages that he pays, but the employee expects the best payment for his work or time. It follows therefore that a mutual agreement should exist between the parties.

The value of money can vary according to economic situations. When money becomes scarce the value will increase, i.e. value of commodities will decrease and interest rates will go up. This also applies to labour where the law of supply and demand is evident. If the demand for labour exceeds the supply the labour becomes more expensive and vice-versa. The cost of purchasing a workers time will become more and therefore time will become more expensive.

GOAL 3

To understand the relationship of a Budget with the programme

Objective 1
How do Financial Budgets relate to the master programme Departmental Budget and Contract Budgets? How is the expenditure controlled?

Objective 2
Prepare budget graphs for a contract showing overall budget and how it is compiled from subsidiary budgets.

Objective 3
Prepare a budget for the Balance Sheet.

Objective 4
How is Cash flow related to the builder's monetary situation?

Objective 5
How do debtors and long collection periods of debts and certificate payments affect the cash flow diagram?

GOAL 3

Objective 1

The Financial Budget enables us to express in financial terms the expectations, targets or objectives of a firm for a given period of time in the future. The Financial Budget being dependent on all other budgets, i.e. departments, contracts, etc, is only finalized after all the other budgets have been compiled. It is based on the subsidiary and operating budgets. The master program being a contract budget will also determine the figures in the Financial Budget.

To maintain the figures in the Financial Budget it becomes necessary to control the figures in the subsidiary and operating budgets. This is done by costing the income and expenditure on a regular basis and continually comparing progress with planned performance.

Objective 2

The master program is drawn up by a planner, who makes a realistic assessment of the operations by using part experience or historical information from past contractor. This amplifies the importance of feed back to head office. The master programme for each contract normally consists of Bar or Gants chart often tied up with an arrow network.

This Bar chart should have the following characteristics to be successful:

1. Based on clearly defined objectives.
2. Simple to understand
3. Flexible so that alterations and alternatives can be incorporated.
4. Provide standards to maintain control.
5. Work must be balanced so that resources (labour and plant) need not return once taken off the site.
6. Resources be used to their fullest extent and not left standing while waiting for other activities.

A Bar chart would contain:

a) The contract heading
b) Weekly dates
c) Sequence of operations showing start and finish.
d) Labour and plant requirements.
e) When building is watertight.
f) Target dates
g) Completion date
h) Percentage work completed
i) Holiday periods
j) Sub-contractors
k) Key items required such as schedules, drawings, etc.

EXERCISE TO BE DONE IN CLASS

Consider a contract worth R830 000 over a period of 15 months and with the following budget details:

Contingency	R 10 000
Overheads	R 30 000
Profit	R 39 500
P & G	R 38 000
Labour and Material	R 592 500
Sub Contractors	R 120 000

Assume that the budget for the work allows for follows:

- Overheads are divided into fixed overheads of R1 000 per month and variable overheads where:
  - 40% is spent in the first 4 months
  - 30% in the next 5 month
  - 30% in the next 6 months
- P & G's are divided as follows:
  - R10 000 in the first 2 months
  - R10 000 in the next 4 months
  - R10 000 n the next 9 months
- Sub – Contractors:
  - R10 000 in the first & 11th month
  - R10 000 in the second & 13th month
  - R25 000 in the fifth & 7thmonth
  - R10 000 in each of last 2 months
- Labour and Material
  - See Ghantt chart on page 19

Note:

- 60 day settlement period for materials
- 30 day delay payment to sub-contractors
- 2 weeks delay between claim and day that payment is received.

Objective 4

Production is dependant on money (cash) available to finance work. In building operations cash is required to pay for wages, material and certain P & G items before any return or payment is received. To produce work in the most economical way cash should be available pay wages and material because borrowed money is very expensive and extra cost is incurred due to interest on money.

The cash flow situation must be studied to ensure that accounts and debts are paid as soon as possible and enough money is available for such payments. Large outstanding debts may enhance the available cash but could lead to problems with supplies. Outstanding monies from clients can also have a detrimental effect on cash available especially when collecting periods extended beyond the limits as laid down.

Cash flow therefore relates to the quick and efficient collecting of outstanding monies. For the builder it will be important to control the issue and payment of certificates and complete

all maintenance work as early as possible so that money, such as retention money, does not lie idle for long periods.

Money is also tied up with time because R100 is worth more to a person at present than R100 in a year's time. This is also the case with money owing to the contractor. The sooner the money is paid to him the sooner he will be able to use or invest it. All debts to the contractor must be collected as soon as possible and payment of debts to other should be delayed as long as possible.

The two aspects of cash flow that emerge from this are:
1. Positive cash flow money received.
2. Negative cash flow money paid out.

The general trend on any contract is that money spent exceeds the money coming in the first stages of the contract. Only when the profit of the contract with a profit of R39 500 is erected in 15 months and everything goes according to plan.

The income and expenditure is illustrated in a possible two weekly situation.

Month	Date	Wages	Plant, O/H & P&G	Materials.	Sub-Contractor	Total	Q.S. Valuation	
							Cert. Value	Less Ret.
JAN	13	5 000	3 000	-		8 000		
	27	5 000	4 500	-	10 000	19 500	27 000	24 300
FEB	10	5 000	3 000	-	-	8 000		
	24	5 000	4 500	-	15 000	24 500	31 000	27 900
MAR	9	9 000	2 000	9 000	-	20 000		
	23	9 000	3 000	10 000	-	22 000	48 000	43 200
APR	6	4 000	2 000	10 000	-	16 000		
	20	5 300	3 000	11 200	-	19 500	39 000	35 100
MAY	4	6 000	2 000	12 000	-	20 000		
	18	6 500	2 400	12 000	25 000	45 900		
JUNE	1	6 500	1 000	12 000	-	19 500	88 000	79 200
	15	9 500	1 400	13 000	-	23 900		
	29	9 500	2 000	14 000	-	25 500	52 000	46 800
JULY	13	9 000	1 900	15 000	-	25 900		
	27	8 000	2 000	15 000	25 000	50 000	80 000	72 000
AUG	10	10 000	1 900	17 300	-	29 200		
	24	10 000	2 000	20 000	-	32 000	63 000	58 000
SEPT	7	11 000	1 900	15 300	-	28 200		
	21	11 700	2 000	15 000	-	28 700	60 000	60 000
OCT	5	11 700	1 000	12 550	-	25 250		
	19	10 450	1 750	12 000	-	24 200		
NOV	2	9 000	1 000	2 000	-	22 000	74 000	74 000
	16	9 000	1 000	16 050	-	26 050		
	30	8 950	2 750	10 000	10 000	31 700	60 000	60 000
DEC	14	8 000	1 000	7 750	-	16 750		
	28	6 250	2 750	6 000	-	15 000	34 000	34 000
JAN	11	8 650	1 000	8 350	-	18 000		
	25	9 000	2 750	8 000	15 000	34 750	55 000	55 000
FEB	8	10 450	1 000	11 550	-	23 000		
	22	10 000	2 750	10 000	10 000	32 750	60 000	60 000
MAR	6	8 000	1 000	6 200	-	15 200		
	20	4 000	1 000	5 000	-	10 000		
	31	3 800	1 750	4 000	10 000	19 550	49 000	49 000
		262 250	68 000	338 250	120 000	780 500	820 000	41 500
								820 000

One way to obviate financing is to delay payments to suppliers and Sub-contractors. This will improve the cash flow position but discounts will most probably be sacrificed.

Another factor to consider is that everything may run smoothly and payment is received on date but the contract was under priced and payment to suppliers was deferred, then the picture may appear rosy up to the last couple of weeks when cash flow will be negative. If several contracts are involved then the cash flow between them could appear very healthy and insolvency will be difficult to detect.

Considering the time/money relationship is the cash flow exercise then we know that the negative cash flow in the beginning of the contract has a greater impact on the finances than the positive cash flow at the end of the contract.

Rate of return involves calculating the rate of return on the working capital and can be shown as a percentage profit on the average working capital.

Example:	Average working capital	R9 000
	Profit	R3 000

$$\text{Rate of return} = \frac{3\,000}{9\,000} \times 100 = 33\tfrac{1}{3}\%$$

SIMPLIFIED EXAMPLE OF BUDGETING AND CASH FLOW (RETENTION EXCLUDED)

Construction of a house: Tender price = R60 000
Estimated price = R45 000

ASSUMPTIONS:

1. Payment for work done and material on site (as per Q.S. Valuation) is received one month after valuation.
2. Labour wage payments are done weekly.
3. Material suppliers and sub-contractors are paid at the end of the following month (30 day settlement – Materials used in month 1 is paid for at end of month 2).
4. Monthly costs are:

   Labour (R5 000) + Material (R5 000) + Sub-Contractors (R5 000) = R15 000.

5. Monthly Income: Month 1 = R15 000
   Month 2 = R30 000
   Month 3 = R15 000

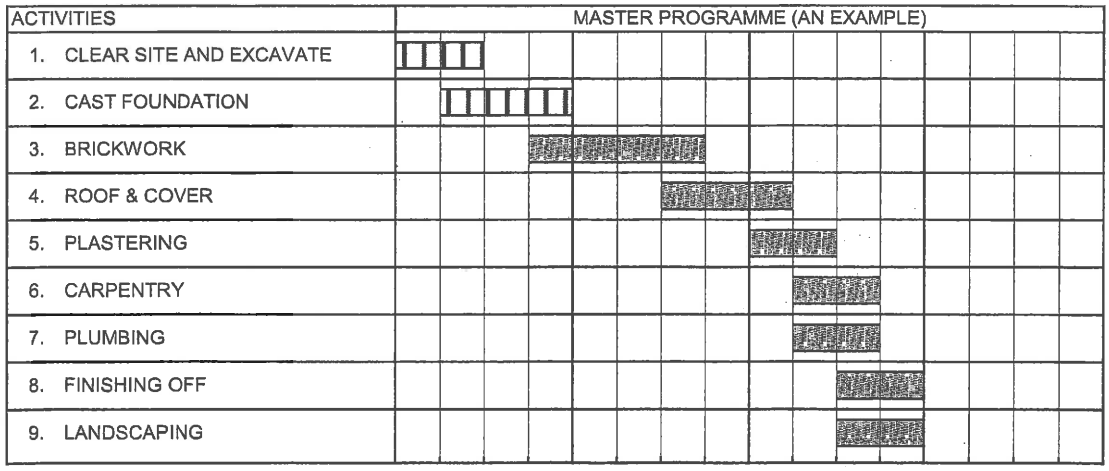
CALCULATIONS:

1. Gross Cash = Cumulative Income of Previous Month minus cumulative expenditure of Present Month.

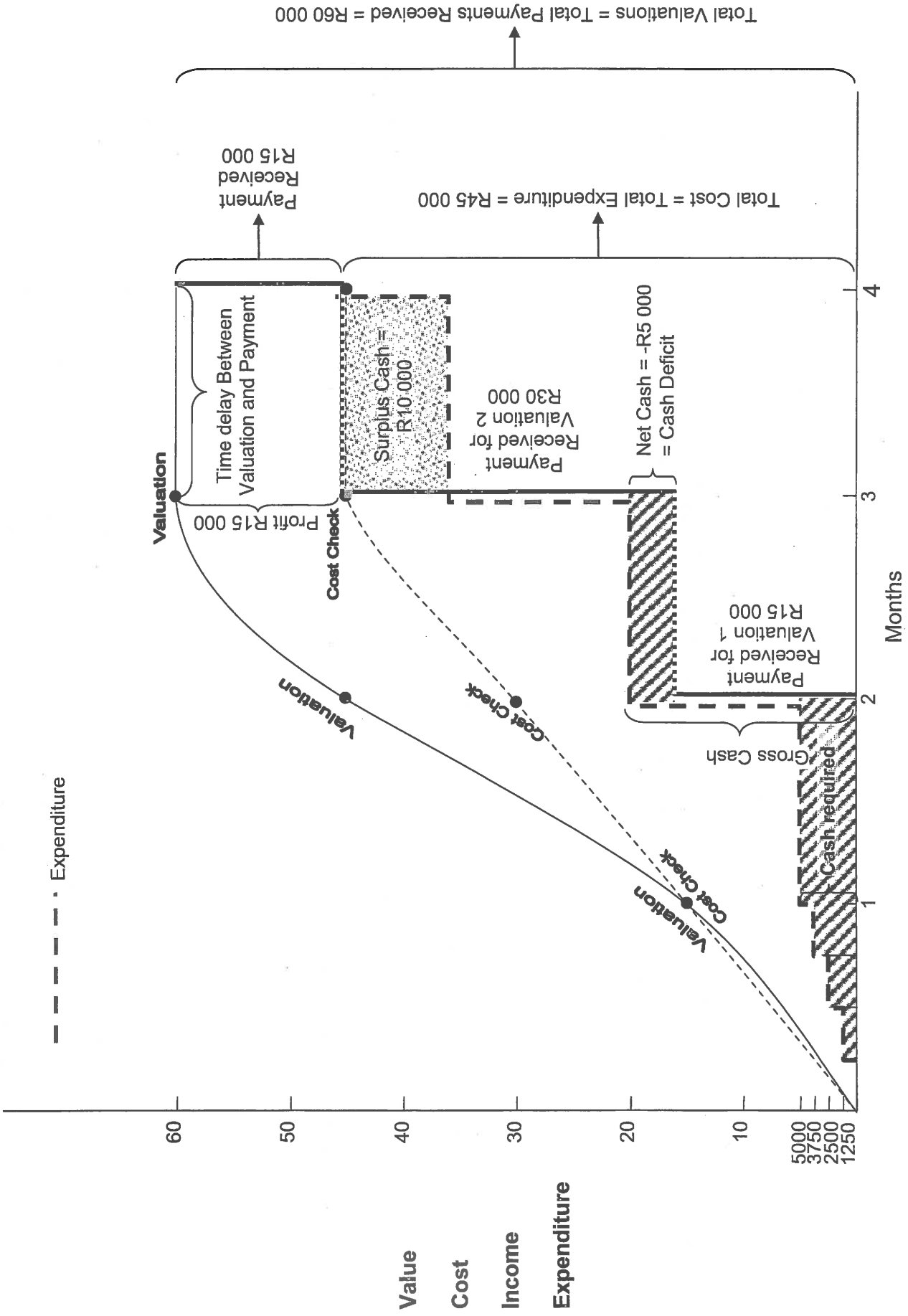
   G.C. = I_c (previous) - E_c (present)

2. Nett Cash = Cumulative Income of Present Month minus cumulative expenditure of Present Month.

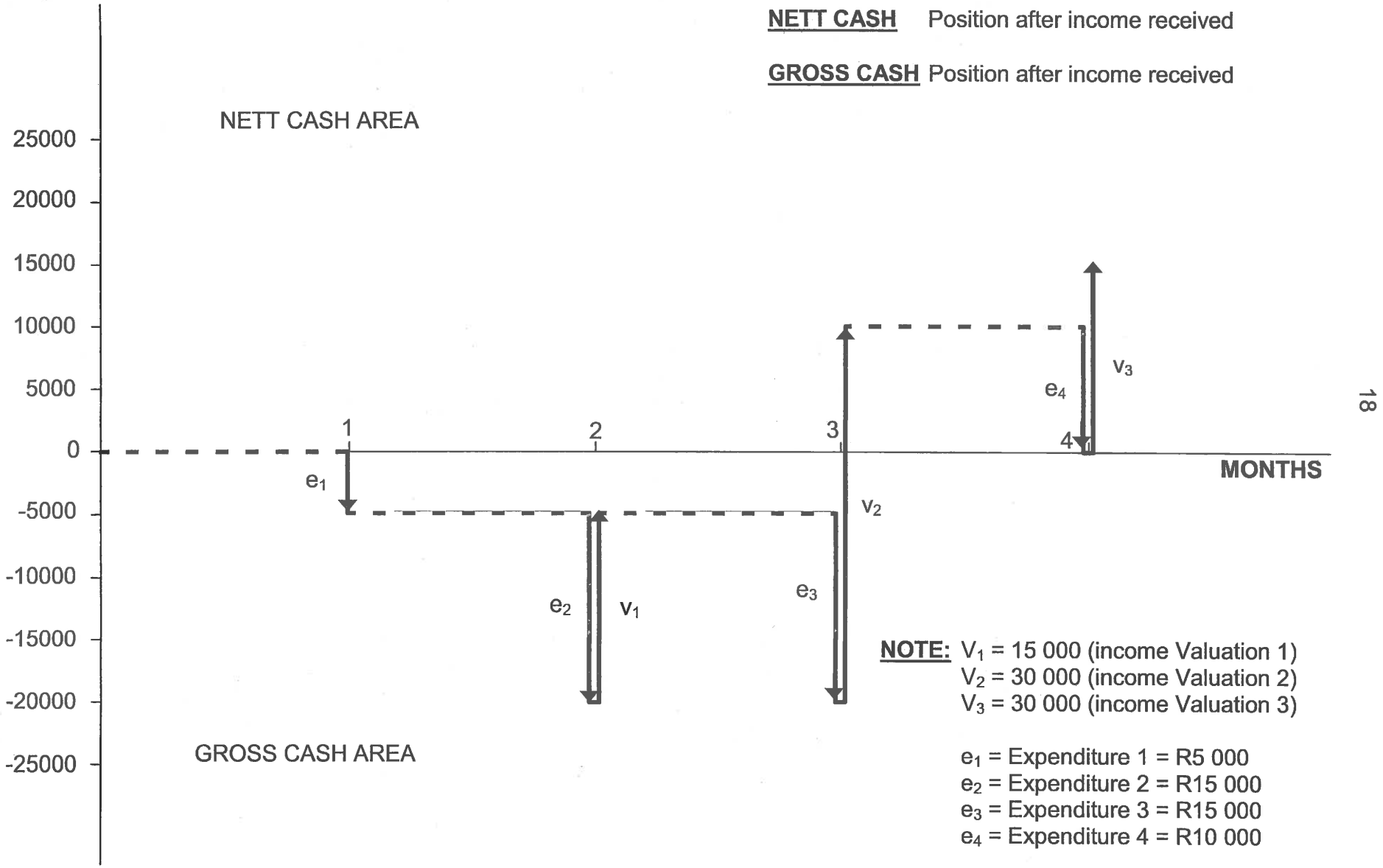
   N.C. = I_c (present) - E_c (present)



MONTHS	0	1	2	3	4	Total
1. Monthly Cost (Cost incurred)		15000	15000	15000		45000
1.1 CUMULATIVE COST		15000	30000	45000		45000
2. Actual Expenditure (Money Paid)		5000	15000	15000	10000	45000
2.1 CUMULATIVE EXPEN.		5000	20000	35000	45000	45000
3. Monthly Income (Cert. Value)		15000	30000	15000		60000
3.1 CUMULATIVE VALUE		15000	45000	60000		120000
4. Actual Revenue (Money Received)		0	15000	30000	15000	60000
4.1 CUMULATIVE INCOME Rev		0	15000	45000	60000	120000
5. GROSS CASH - Before Revenue		-5000	-20000	-20000	0	Gross
6. NETT CASH - After Revenue		-5000	-5000	10000	15000	Nett


Total Valuations = Total Payments Received = R60 000
Total Cost = Total Expenditure = R45 000
Payment Received R15 000
Valuation
Time delay Between Valuation and Payment
Profit R15 000
Cost Check
Surplus Cash = R10 000
Payment Received for Valuation 2 R30 000
Net Cash = -R5 000 = Cash Deficit
Payment Received for Valuation 1 R15 000
Gross Cash
Cash required
Valuation
Cost Check
Valuation
Cost Check
Expenditure
Months
Value
Cost
Income
Expenditure
60
50
40
30
20
10
5000
3750
2500
1250
1
2
3
4

Cash Flow Graph



EXERCISE 1

TRADE	MONTH															%		TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	MAT	LAB	
EXCAVATOR	0	0	0	0												0	100	30 500
	10000	10000	10000	500														
CONCRETOR			19000	19000	19000	19000	19000	19000			19000					70	30	190 000
			8500	8500	8000	8000	8000	8000			8000							
BRICKLAYER					11800	11800	11800	11800	11800	11800	700					55	45	130 000
					9000	9000	9000	9000	9000	9000	4500							
WATERPRFG.						3000			12000							60	40	25 000
						2000			8000									
CARPENTER										4050	4050	4050	4050	4050		45	55	45 000
										4950	4950	4950	4950	4950				
IRONMONGER														5200	5200	65	35	16 000
														2800	2800			
METALWORKER								4500	4500	4500	4500	4500	4500	4500		75	25	42 000
								1500	1500	1500	1500	1500	1500	1500				
PLAST & PAVIOR								2800	2800	2800	2800	2800	2800	2800	2800	40	60	56 000
								4200	4200	4200	4200	4200	4200	4200	4200			
PLUMBER				2200						2200	2200	2200			2200	55	45	20 000
				1800						1800	1800	1800			1800			
PAINTER												200	5000	5000	5000	40	60	38 000
												1800	7000	7000	7000			
TOTAL MATERIAL	0	0	19000	21200	30800	33800	30800	38100	31100	25350	33250	13750	16350	21550	15200			592500
TOTAL LABOUR	10000	10000	18500	10800	17000	19000	17000	22700	22700	21450	24950	14250	17650	20450	15800			

EXERCISE 2:

Determine net cash and plot estimated expenditures.

Month/Date		Wages	Plant, O/H and P&Gs	Materials	Sub-Contr.	Total	Amount Received	Net Cash Accumulated Cash Flow
JAN	13	5000	3000	-	-	8000		
	27	5000	4500	-	-	9500		
FEB	10	5000	3000	-	10000	18000	24300	
	24	5000	4500	-	-	9500		
MAR	9	9000	2000		15000	26000	27900	
	23	9000	3000		-	12000		
APR	6	4000	2000		-	6000	43200	
	20	5300	3000	19000	-	27300		
MAY	4	6000	2000	-	-	8000	35100	
	18	6500	2400	-	-	8900		
JUNE	1	6500	1000	21200	-	28700		
	15	9500	1400		25000	35900	79200	
	29	9500	2000	36000	-	47500		
JULY	13	9000	1900		-	10900	46800	
	27	8000	2000	27000	-	37000		
AUG	10	10000	1900		25000	36900	72000	
	24	10000	2000	30000	-	42000		
SEPT	7	11000	1900		-	12900	58000	
	21	11700	2000	37300	-	51000		
OCT	5	11700	1000		-	12700	60000	
	19	10450	1750		-	12200		
NOV	2	9000	1000	30300	-	40300		
	16	9000	1000		-	10000	74000	
	30	8950	2750	36550	-	48250		
DEC	14	8000	1000		10000	19000	60000	
	28	6250	2750	26050	-	35050		
JAN	11	8650	1000		-	9650	34000	
	25	9000	2750	13750		25500		
FEB	8	10450	1000		15000	26450	55000	
	22	10000	2750	16350	-	29100		
MAR	6	8000	1000		10000	19000	60000	
	20	4000	1000		-	5000		
	31	3800	1750	21550	-	27100		
APR	17				10000	10000	49000	
	31			15200	-	15200	20750	
JUNE	30						20750	
TOTALS		262250	68000	330250	120000	780500	820000	

EXERCISE 3

Draw the budget graph a house costing R88 000 over 6 months.

The price is built up as follows:

- Labour & Material 45 000
- Sub-contractors 29 000
- Fixed Overheads 6 000
- Profit 8 000

Assume that the budget parameters are as follows:

- Labour paid fortnightly
- Material paid on 30 day settlement
- Sub-contractors paid on 30 day settlement
- Overheads allocated at 10% of total
- Profit calculated at 10% of total costs
- Retention: 10% of claim throughout
- Total retention released 3 months after last claim

Use the attached Bar chart figure 1 for monthly allocations to prepare budget and cash flow graphs at two weekly intervals.

Fig. 1

TRADE	Months						LAB	MAT	TOTAL
	1	2	3	4	5	6	%	%	
EXCAVATOR							100	0	2 000
CONCR. & FMWK.							30	70	3 000
BRICKWORK							55	45	15 000
CARPENTRY							50	50	10 000
IRONMONGERY							25	75	2 000
PLASTERING							60	40	7 000
PAINTING							50	50	6 000
SUBCONTRACT									29 000

EXERCISE 4

Calculate the accumulative cash flow on the attached detail list figure 2 and draw the cash flow diagram on two weekly basis considering payments as indicated.

N.B.: Use the following scales

Question 1	:	Horizontal	2cm	= 1 month
		Vertical	2cm	= R10 000
Question 2	:	Horizontal	1cm	= 2 weeks
		Vertical	2cm	= R10 000

Fig. 2

DATE		EXPENDITURE					INCOME	
		WAGES	OVER-HEADS	MATERIAL	SUB-CONTR	TOTAL	AMOUNT RECEIVED	ACCUMULAT. TOTAL
JUN	15	1000						
	19	1300	1 000					
JUL	13	1 400						
	27	1 650	1000				6 000	
AUG	10	1 450			2 000			
	24	1 300	1 000	3 650				
SEPT	7	2 700					7 000	
	21	3 700	1 000					
OCT	5	3 050		2 250				
	19	3 050					14 000	
NOV	2	1 500	1 000	5 600	7 000			
	16	1 000						
	30	750	1 000	5 400			14 000	
DEC	14							
	28			4250	10 000		25 000	
JAN	25				10 000		22 000	

EXERCISE 5

BUDGETING AND CASH FLOW EXERCISE: CONTRACT X

A financial budget is the representation (table or graphic) of the value of work done over a period of the contract. This is drawn up from the Bar chart which is priced or valued and added to give a total monthly value of work done. The progressive totals are then plotted in a graph to show the planned earnings. The actual earnings can be plotted against the planned to give a comparison of the progress of the work from a financial point of view.

The method used to evaluate the various trades is to divide the price of each trade by the time to give the value on a weekly or monthly basis.

I.e. Excavations may have a total price in the B of Q R30 000 and the work is planned over a period of six weeks then the amount per week would be R5 000 expected turnover or R20 000 for the first month and R10 000 for the second month. By evaluating each trade for each month the total value of work for that month can be ascertained.
The graph is usually drawn on a monthly basis to allow control from certificate values.

Below you are given information and a program for contract. The figures were obtained from the priced nett bill of quantities (excluding overheads and profit).

Do the required calculations and draw budgeted value, income, cost, expenditure, nett cash and gross graphs at monthly intervals. Cost calculations need to be done at monthly intervals only.

Information:

(i) The electrical work, lifts and R50 000 of excavations will be done by sub-contractor.
(ii) Assume that the split between labour and material on all the own work is 55% labour and 45% material.
(iii) Labour will be paid fortnightly.
(iv) Payment is delayed for two weeks.
(v) Payment to sub-contractor is delayed the month after submission of their claim.
(vi) Suppliers will be paid on a 60 day settlement period (VAT, trade and cash discounts are disregarded).
(vii) Retention is 5% - total released 3 months after completion.
(viii) Profit mark-up is 10%.
(ix) Overheads of R2 500 per month are allocated to the contract for the full duration thereof.
(x) Escalation can be ignored in budgetary calculations.

Excavation	60 000	Of which R50 000 is S.C.
Concrete structure	354 000	
Concrete non-structure	40 000	
Brickwork	220 000	
Waterproofing	26 000	
Carpentry	152 000	
Ironmongery	48 000	
Paving and plastering	168 000	
Plumber	276 000	
Painter	84 000	
Reinforcing steel	54 000	
Electrical works	206 000	
Lifts	200 000	
Flooring	100 000	
P & G	120 000	

TRADE	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	TOTALS (R)
EXCAVATIONS	53 000	7 000										60 000
CONCRETE STRUCT.		118 000	118 000	118 000								354 000
CONCRETE NON. STRUCT.			20 000	20 000								40 000
BRICKWORK			51 000	85 000	68 000	16 000						220 000
WATERPROOFING				26 000								26 000
CARPENTLY						76 000	38 000			38 000		152 000
IRONMONGERY											48 000	48 000
PAVING AND PLASTERING					16 800	33 600	42 000	33 600	42 000			168 000
PLUMBER		46 000				46 000	46 000			46 000	92 000	276 000
PAINTER								15 750	26 250	21 000	21 000	84 000
REINF. STEEL	9 000	18 000	18 000	9 000								54 000
ELECT. WORK		14 000	14 000	14 000		28 000			14 000	56 000	66 000	206 000
LIFTS										50 000	150 000	200 000
FLOORING										34 000	66 000	100 000
P & G	15 000	15 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	10 000	120 000
OVERHEADS												
TOTAL												
LABOUR												
MATERIAL												
SUBCONTRACTORS	50 000											
PLANT												

BUDGETARY AND CASH FLOW CALCULATIONS – PROJECT X

	Weeks	Labour R	Material R	Sub-Contractor R	Plant R	Overheads	Escalation R	Monthly Total Cost R	Cumulative Cost R	Expenditure (Cost Commitment) R	Cumulative Expenditure R	* Gross Value (Cumulative) R	Nett Monthly Income Due - See Form 1 R	Cumulative Income Due R	++ Net Cash Flow R	oo Gross Cash Flow R
TOTALS																
	0															
	1															
	2															
	3															
	4															
	5															
	6															
	7															
	8															
	9															
	10															
	11															
	12															
	13															
	14															
	15															
	16															
	17															
	18															
	19															
	20															
	21															
	22															
	23															
	24															
	25															
	26															

* Value = Cost $\times \frac{100 + \%\ profit}{100}$

If value from S-curve

then cost = Value $\times \frac{100}{(100 + \%\ profit}$

++Net cash Cumulative income – cumulative expenditure after payment
Cumulative income present – cumulative expenditure present

oo Gross cash Cumulative income – cumulative expenditure before payment
Cumulative income previous – cumulative expenditure present

FORM I – INCOME CALCULATIONS (FROM VALUATION)				
Month 1	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation I			INCOME FOR WORK DURING MONTH
Month 2	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 2			
Month 3	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 3			
Month 4	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment			
Month 5	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation I			
Month 6	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 2			
Month 7	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 3			

FORM I – INCOME CALCULATIONS (FROM VALUATION)				
Month 8	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation I			INCOME FOR WORK DURING MONTH
Month 9	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 2			
Month 10	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 3			
Month 11	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment			
Month 12	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation I			
Month 13	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 2			
Month 14	Amount due: (Valuations cert.) Less retention % Total payment due to date Less previous payment Amount due valuation 3			

"PROFIT AND LOSS" AND "CASH FLOW" ANALYSIS

- The contract value = R132 300
- Every four (4) weeks a valuation is drafted.
- 10% Retention up to a maximum of 5 % of the contract value is held.
- Payment is effected two (2) weeks after valuation.
- Mark-up on cost = 15%
- 25% of cost is paid out every two weeks for labour.
- 10% of cost is paid out every four weeks for overheads and salaries.
- The rest of the cost is paid out 4 weeks after the valuation to sub-contractors and suppliers.
- The contract period is 24 weeks.
- 50% of retention is released 4 weeks after completion and the rest after 8 weeks.