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BUDGETING, BUDGETARY CONTROL AND MANAGEMENT

INFORMATION IN THE HIGHWAYS DEPARTMENTS

A thesis, submitted for consideration for the award of Doctor of Philosophy

by

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September 1975

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Budgeting, Budgetary Control and Management Information in Highways Departments

SYNOPSIS

The need for an adequate information system for the Highways Departments in the United Kingdom has been recognised by the report of a committee presented to the Minister of Transport in 1970, (The Marshall Report).

This research aims to present a comprehensive information system on a sound theoretical basis which should enable the different levels of management to execute their work adequately.

The suggested system presented in this research covers the different functions of the Highways Department, and presents a suggested solution for problems which may occur during the planning and controlling of work in the different locations of the Highways Department. The information system consists of:-

- 1. A coding system covering the cost units, cost centres and cost elements.
- 2. Cost accounting records for the cost units and cost centres.
- 3. A budgeting and budgetary control system covering, the different planning methods and procedures which are required for preparing the capital expenditure budget, the improvement and maintenance operation flexible budgets and programme of work, the plant budget, the administration budget, and the purchasing budget.
- 4. A reporting system which ensures that the different levels of management are receiving relevant and timely information.
- 5. The flow of documents which covers the relationship between the prime documents, the cost accounting records, budgets, reports and their relation to the different sections and offices within the department.

A comprehensive cost units, cost centres, and cost elements codes together with a number of examples demonstrating the results of the survey, and examples of the application and procedures of the suggested information system have been illustrated separately as appendices. The emphasis is on the information required for internal control by management personnel within the County Council.

Key words: 'Costs, Highway Maintenance'

TO

MY WIFE, MY SON

AND

THE MEMORY OF MY FATHER

ACKNOWLEDGEMENTS

In regard to the preparation and completion of this thesis, I am grateful for the generous help and assistance of a number of individuals and organisations. To the Interdisciplinary Higher Degrees Scheme at the University of Aston in Birmingham and the Transport and Road Research Laboratory my thanks for providing me with the opportunity to carry out this research, and to the Egyptian Government who provided me with the financial support through the research studentship.

Mr J E Smith, as the main supervisor of the project spent many hours discussing the work, and suggesting useful ideas to overcome the difficult problems throughout the research. Mr L M Ford, as the associate supervisor was always willing to offer his help in coping with the civil engineering problems. Mr R Hardman, as the industrial supervisor, and Mr B S Parmenter, both of TRRL, offered me much help in conducting the survey and the interviews in the different Highways Departments, and provided useful criticism and comments throughout the research.

Secretarial assistance for the project was provided by the IHD Scheme and the TRRL, and I am grateful to Mrs Lynda Winchurch and Mrs Heather Billington in particular for typing this dissertation within the scheduled period.

A final word of thanks is due to all members of staff and workers in the Highways Departments visited during the preparation of this project for their help and encouragement.

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INTRODUCTION

In October 1967 a committee was appointed to consider and make recommendations on the planning, execution, and financial control of highway maintenance work. The committee submitted and published its report which is known as the "Marshall Report" in 1970. (1) The report laid emphasis on the need for an information system in highway maintenance, as it has been found that many authorities exercise control over the flow of expenditure but do not relate it to output; the report, therefore, presents in some detail a method of controlling materials, labour, and plant concerned in highway maintenance, designed to secure at the same time effective financial management. The examples given by the "Marshall Report" were only for guidance, therefore, the Transport and Road Research Laboratory, (Construction Methods Division), took the initiative and proposed that the information system required for the highway maintenance organisation should be tackled through the introduction of a number of sub-systems each dealing with a specific part of the organisation, and all these systems should then be integrated into an overall system for the Highways Department.

Initially, a research project into the sub-system for plant utilisation was suggested to the Interdisciplinary Higher Degrees Scheme, The University of Aston in Birmingham. A survey was then carried out by the researcher, in the form of a questionnaire and personal visits to a number of Highways Departments in the United Kingdom in order to collect information about their existing information system.

Report of the Committee on Highway Maintenance (London, Her Majesty's Stationery Office, 1970)

The following are the general conclusions derived after considering the analysis of the data obtained from the questionnaire and the interviews with the appropriate personnel in the Highways Department visited. (2)

- 1. There are both a lack of organisation structure and written descriptions of job specifications. This leads to a lack of appropriate communication between the different levels of management and inadequate definitions of responsibility for members of the management staff.
- 2. The cost accounting records are used only for calculating the total costs of the work carried out by the department. This prevents the use of the costing information in controlling the work and in decision making.
- 3. The Highways Department uses a financial budget, which is a part of the County Council annual budget, with some details concerning the total cost of the different major maintenance or improvement operations as the basis for controlling the work. This may achieve control over the annual expenditure of the department, but will not provide the different levels of management with budgets which help them in planning and controlling the work.
- 4. The different levels of management do not receive the information needed for decision making in the right form and at the right time. This is because of (1) the insufficient information obtained from the existing costing records and the departmental budget; (2) the lack of appreciation of the types, frequency, and form of information which is required for the different levels of management.

These conclusions made it clear that the existing information systems in general are inadequate, but further, it was also evident that the inter-relationships between plant and its management and the overall operations within the Highways Department - this covers the maintenance and improvement work carried out by the department direct labour - are

Full details of the questions included in the questionnaire, the analysis of the answers received from the Highways Departments, and conclusions are included in Appendix 1.

so strong that there was little point in conducting a narrow study aimed solely at plant utilisation. Therefore, it has been decided that the research should cover the framework of the overall information system for the Highways Department, which covers the maintenance and improvement work, and the central repair depot including plant utilisation.

Logically, this system should stand on a theoretical base and, at the same time, should be practical; this thesis is intended to be the framework of such a system. (The research has been carried out as described in Figure Iii)

The research also covers the relationship between the prime documents, cost records, budgets, and reports, and their relationship with the different locations of management. Each part of this research has been described in detail, and examples of the records, schedules, budgets and report forms have been illustrated throughout the research; also, quantitative examples have been used to demonstrate certain points when needed.

It is hoped that the use of this system will present information to the different levels of management in the Highways Department which is reliable and relevant for both strategic and day to day planning, control and decision making.

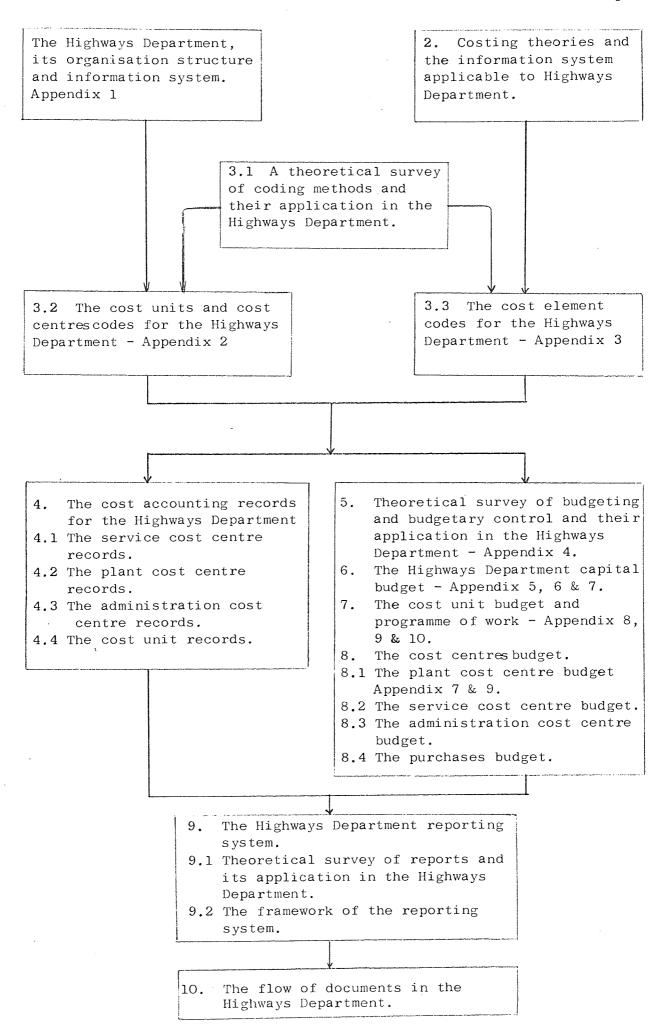


Fig. I.1 The framework of the research.

CHAPTER 1

THE HIGHWAYS DEPARTMENT, ITS ORGANISATION STRUCTURE AND INFORMATION SYSTEM

The Highways Department is one of the departments of a local authority, which is responsible for maintaining and improving the counties roads. The counties roads are divided into two categories, (1) trunk roads including motorways, which are the responsibility of the Department of the Environment. However, the Department has not the organisation to maintain and improve these roads and therefore the actual work is usually carried out by the local Highway Authority, which in this case acts as an agent for the Department of the Environment, and (2) the nontrunk roads, which are the specific responsibility of the local authorities. The local authorities charge the Department of the Environment with the cost of the work carried out on its behalf on the trunk roads and motorways; on the other hand, the cost of maintaining and improving the non-trunk roads is financed from the counties rates. One of the aims of the Highways Department is therefore, to carry out the maintenance and improvement work required for the counties roads as efficiently as possible and at the same time as economically as possible. this aim, the different levels of management within the Highways Department require information which helps them in planning and controlling the work, and at the same time provide them with the basic information required for decision making.

The existing organisation and information systems within the Highways Departments have been examined, (1) and it is concluded that there is a need for a Highways Department organisation structure which should be based on the most appropriate type of the existing types of organisation structures, this to establish clear lines of responsibilities and authorities for the department, and at the same time facilitate communication between the different levels of management.

In the form of a questionnaire and personal visits to nine counties representing a representative sample of Highway Authorities in Great Britain. See Appendix 1.

Theoretical introduction to organisation structures

An effective organisation structure needs to be appropriate for the work to be done and must have simple lines of authority, responsibility and accountability and clear channels of communication, and the following rules should be followed in order to build the organisation structure of any enterprise. (2)

- 1. Definite and clear-cut responsibilities should be assigned to each level of management, and no changes should be made in the scope of a position without a definite understanding to that effect on the part of all persons concerned.
- Responsibility should always be coupled with corresponding authority.
- 3. Employees occupying positions in the organisation should not be subject to definite orders from more than one source, and orders should never be given to subordinates over the head of the responsible manager.
- 4. Promotion, wage changes and disciplinary action should always be approved by the manager immediately superior to the one directly responsible, and criticisms of subordinates of employees should be made privately.
- 5. Any manager or employee should not be assistant to and at the same time a critic of the person he is assistant to, and any manager whose work is subject to regular inspection should, whenever practicable, be given the assistance and facilities necessary to enable him to maintain an independent check of the quality of his work.

The organisation structure may differ in terms of the peculiar needs of a given enterprise, however, there exist five principle types of

² C HEYEL. "The Encyclopaedia of Management" (London, The Reinhald Publishing Corporation 1963). p. 620.

organisation structure with varying degrees of complexity appropriate to the enterprise in terms of its size, and type of product. These types of structures are: (3)

- Line organisation. Sometimes referred to as military organisation, it assumes a direct straight-line responsibility and control from the general manager to the foreman.
- Line and staff organisation. This type of structure has been introduced as a result of the appearance of the complex organisation which necessitates the appointment of assistants to executives. According to this type of structure, executives retain supervisory authority, and control over the activities of the personnel of their departments, and at the same time, delegate specific advisory responsibilities to their assistants. As the activities of these assistants increase, other personnel are added, this eventually forming staff departments, supplementing the line organisation.
- 3. Functional organisation. The development of staff departments led to attempts toward complete organisation on a functional basis. This removed the staff specialist from their "assisting" capacity and gave them authority and responsibility for supervision and administration of the function replacing the operating foreman. This type of organisation structure proved to be a failure because each worker had a multiplicity of bosses, i.e. one for production and scheduling, one for inspection, one for maintenance etc.
- 4. <u>Line and functional organisation</u>. According to this type of organisation structure, the functional staff departments are given responsibility and authority within the enterprise policy established in consultation with the line organisation over specialized activities such as inspection, work study, etc. These

L L BETHEL, F S ATWATER, G H E SMITH & H A STACKMAN, Jr.
"Industrial Organisation and Management". Fifth Edition (New York,
McGraw-Hill Book Company 1971) pp. 36-41.

services functions are performed by specialized personnel, apart from the line operators who are responsible to their line supervisors. The staff department directs its function in the production units up to the point where disagreement occurs, then, the disagreement should be taken to the administrative head of the production and the staff units involved, and ultimately may be carried to higher management.

5. <u>Line, functional staff and committee organisation</u>. This type of organisation structure exists in the large enterprises. A permanent-standing - or a temporary committee may be added to the line and functional staff organisation to facilitate coordination and cooperation within the enterprise.

The Highways Department organisation structure

The Transport and Road Research Laboratory presented a report on the Highway Authorities' organisation. The aim of this report, as the writers put it, is

"To describe the desirable common philosophy within which local variations can be accommodated, but which can be used by local highways authorities as a basis for establishing broadly (and recognisably) similar organisations to achieve broadly similar objectives".

The report proposals for the head office and divisions of the maintenance organisation will be used as the basis of the suggested structure of the Highways Department, and the following is a summary of these proposals:

The different posts of management have been described by numbered tiers. The County Surveyor and his deputy are regarded as functioning jointly at the first tier. It is suggested that "practice grouping of the various activities of administration, management, traffic engineering, design, works, under 2nd tier managers, is a matter of local decision within the individual authorities, (5) these services are necessary to the Highway

B S PARMENTER, I.E. LANCASTER & B E COX. "Highway Authorities
Organisation" (Crowthorne, Transport and Road Research Laboratory)
p. 2.

⁵ Ibid p. 8.

Department. The report did not describe in detail the structure of these departments, as the report is only concerned with the maintenance organisation. The suggested structure of the maintenance organisation is shown diagrammatically in Figure 1.1, and its description is summarized as follows:-

The head of the maintenance organisation should be at the second tier, and to gain adequate support for him, it is proposed that consideration should be given to the appointment - at the third tier - of engineers responsible for works, surfacing, and construction, in the head office. The technical and administrative assistants who are required for these posts should depend upon the assessment of the work load of each individual authority. It is also suggested that the county should be divided into a number of divisions each covering the lengths of road or the order of 1000 to 1600 km, subject to the road and population density. The divisional manager should be appointed at the third tier. The total number of divisional supporting staff should be based upon the work load in each divisional area, but bascially there should be at least two engineers at the fourth tier in each division, the first should be responsible for maintenance work and the second for the construct-At the fifth tier there should be personnel, responsible to the fourth tier maintenance engineer, for planning and execution of routine maintenance and each of them should be responsible for the operation of 3-4 maintenance gangs and one or two "fire-brigade" gangs. In the same level, there should be at least one post responsible for supervision of the public utilities street act, the Highway Code, and estate development and highways works under planning consent. Personnel responsible for the execution of the construction programme, should also be appointed at this tier.

The report also emphasised the need for a plant and vehicle organisation in the form of a central repair depot. This depot should be under the direct control of the Highways Department, and should be responsible for providing services for the other departments of the local authority. (7)

⁶ Ibid pp.8-10.

⁷ Ibid p. 11.

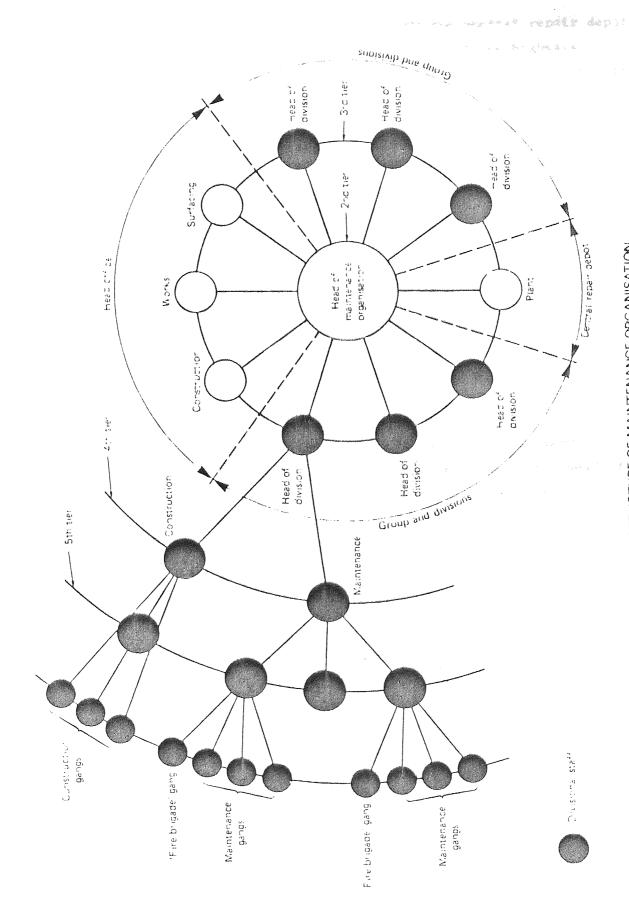


FIG 14SUGGESTED STRUCTURE OF MAINTENANCE ORGANISATION

The report did not discuss the structure of the central repair depot, or its relation with the other departments within the Highways Department, but it did discuss the qualifications and responsibilities of the plant officer at the thrid tier, who should be in charge of the central repair depot.

It is also suggested, in the report, that within the Highways Department there is a need to contain activities such as cost accounting, work study, etc, under the overall control of a second tier manager. (8)

It is essential, for the purpose of this research, that the overall structure of the Highways Department, which covers the central repair depot, the central laboratory and the administration department should be described in detail in order to identify the relationships between the different sections of the Highways Department. This should be prepared according to the line, functional staff and committee type of organisation previously described.

It is suggested that the structure of the Highways Department should consist of the previously mentioned structure of the head office posts and the divisional posts, and the following structures:-

1. The central repair depot

As suggested by the TRRL report, the depot should be under the direct control of the plant engineer at the third tier, whose responsibilities were cited in detail in the TRRL report, (9) however, it is suggested that an appointment, at the fourth tier, of another plant engineer to act as a deputy to the plant manager should be considered. This deputy should be responsible for the day-to-day work in the central repair depot; he should supervise all plant repairs carried out in the central repair depot and inspect it, if it is carried out by an outside firm. He should also be responsible for the technical supervision of the divisional workshops.

An appointment, at the fifth tier, of personnel responsible to the fourth tier plant engineer is suggested. They should be responsible for advising, supervising, and controlling the work in the central repair

⁸ Ibid p. 11.

⁹ Ibid p. 11.

depot workshops. The number of workshops should be decided according to the need and size of the central repair depot, but, basically, it is suggested that there should be a specialized workshops for maintenance, engine repairs, electric repairs, body repairs and type repairs.

A divisional workshop may exist, in the divisions depots, to carry out small repairs; the deputy plant engineer should be responsible for its technical supervision, under the direct control of the division manager.

2. The central laboratory

The Highways Department may consider the establishment of a central laboratory to carry out all types of analysis needed for the construction or maintenance work. In such a case, the structure of the central laboratory should be the same as the central repair depot, described above. This means that there should be a laboratory manager, at the third tier, responsible for all work carried out in the central and divisional laboratories and it is possible to appoint an assistant, at the fourth tier, if the load of work requires it. A person, at the fifth tier, may be appointed to be responsible for supervising a specialized laboratory within the central laboratory.

The administration department in the Highways Department should be under the overall control of a second tier manager. The location of the administrative department is divided between the head office, the divisions, the central repair depot and the central laboratory, and, in order to distinguish between the head office and the other locations offices, the offices in the head office will be called sections. The number of staff, within each office or section is a local matter and should depend on the load of work in each location, also, the tier of manager may differ from one local authority to another, therefore, the description of the relationship and responsibility of these offices and sections will be described, for each of them, as a unit.

1. The Head Office sections

Generally, the head office sections are concerned with the improvement works in the whole county and the head office expenses. The following is a brief summary of the responsibilities of each section. (10)

1.1 The cost accounting section

This section should be responsible for allocating costs to the appropriate costs units and coding the prime documents provided by the divisions, according to the cost element code, before sending them to the computer. The section should keep the costing and subsidiary records of the improvement works in the county and should also present the actual costing information to any level of management, within the department or outside it e.g. the treasurer's department.

1.2 The Accounting section

The Accounting section should audit the prime documents for the improvement works and the head office expenses, prepare the payroll of the improvement works and the administration staff in the head office, and schedule all invoices for payment and send them to the computer section. This section should also keep the accounting records and file the prime documents.

1.3 The control section

This section is responsible for preparing the operational budgets of the improvement work and presenting the overall budget of the department. It is also responsible for preparing the variance reports of the improvement work, and preparing the programme of work for improvement work all over the county.

Details of these responsibilities are described in the appropriate parts of the suggested costing system.

1.4 Purchasing and storage section

This section is responsible for determining the pricing policy of materials issued from the stores, the level of inventory and the economic order quantity. It is also responsible for preparing, inviting and accepting tenders from suppliers. It should also deal with all the improvement work, prime-document pricing and coding the stores' issue notes. This section is also responsible for preparing the department's purchasing budget.

1.5 Workstudy section

The work study section should be responsible for determining the standard minute values of the maintenance and improvement work and the plant repairs in the central repair depot, also, to calculate the bonus payment for all the improvement workers. It is responsible for providing the control section with all the measures needed to build up the department budget and programme of work.

2. The divisional, central repair depot and central laboratory offices

The administration offices in these locations should be the same as in the head office but with different responsibilities.

2.1 The divisional offices

The divisional offices should be responsible for dealing with the maintenance work documents and records and the administration expenses of the division, accordingly the responsibilities of the divisional offices should be as follows:-

- 2.1.1 The cost accounting office. This office should be responsible for allocating cost to the maintenance cost units, keeping the cost records and subsidiary records of the maintenance operation within the division.
- 2.1.2 The accounting office. This office is responsible for preparing the maintenance workers' payroll and scheduling the division for payment, and filing all the divisional accounting documents and records.

- 2.1.3 The control office. This office is responsible for preparing the maintenance budget and programme of work in the division, preparing the variance reports to the different levels of management within the division and following-up the action taken by them to overcome the reasons for these variances.
- 2.1.4 The purchasing and stores office. This office should be divided into two parts; the first is responsible for keeping the priced inventory records, coding and pricing the prime documents and calculating the levels of inventory and recording materials directly or through the head office; the second part should be responsible for the divisional stores. The stores should prepare the issue notes, the stores requisition notes, the stores received notes and the bin cards.
- 2.1.5 The work study office. This office should be responsible for measuring the work done by the maintenance gangs during the past week and check it against the gangs work sheets, and calculating the bonus payment for these gangs.
- 2.2 In the central repair depot and central laboratory, these offices should be responsible for the same work as in the division offices, taking into consideration the fact that the central repair depot is concerned with plant activity, therefore, the depot offices should deal with plant records, budgets, programme of work, documents etc., and the same applies to the central laboratory.

The size and number of offices in the division, central repair depot, central laboratory may vary according to the local authority circumstances, therefore, the head office sections may carry the responsibilities of any of the administration offices, or, the offices may take some of the sections responsibilities. In this research the responsibilities of the administration offices and section will be as described before.

The administration offices should be under the direct control of the division, central repair depot, central laboratory managers and at the same time under the appropriate section supervisor for technical advice.

3. The budget committee

The budget committee should facilitate the coordination and cooperation of work within the Highways Department. It should be headed by the deputy County Surveyor and membered by all the second and third tier managers in the Highways Department. The committee should be responsible for allocating the available resources to the maintenance and improvement projects, and approving the operational budget and programme of work; it should also be responsible for making any changes in the original budget after the beginning of the year.

Figure 1.2 represents the suggested structure of the Highways Department. There should be a number of divisional structures under the head of the maintenance organisation according to the number of the county divisions. The broken lines represent a technical supervision relationship.

The identification of the responsibilities of each manager and section of the Highways Department requires the availability of appropriate information to help them in carrying out their responsibilities as defined before. The following are examples of situations where specific information is required and, which cannot be provided to the person responsible from the exisiting information systems in the Highways Department.

- The information required for preparing the plant capital expenditure budget concerning the size of fleet to be kept in the central repair depot.
- 2. The information required for planning and the day-to-day controlling of the maintenance and improvement operations carried out by the different gangs in the different locations of the counties.
- 3. The information required to ensure full utilization of the County Council owned plant in the central repair depot, and one sites.
- 4. The information required for planning and controlling the day-to-day work carried out in the central repair depot.

DEPARTMENT STRUCTURE OF HIGHWAYS FIG.1.2 SUGGESTED

- 5. The information required for calculating the cost of the work carried out by the Highways Department for outside parties.
- 6. The information required for preparing the department purchases budget which allows for the purchasing of bulk quantities based on the County Council annual tender.

A better management information system based on one of the existing costing methods, which related the actual costs to budgets dependent upon a programme of work, should facilitate the preparation of reports which contain the information required to meet the above criteria.

CHAPTER 2

COSTING THEORIES AND THE INFORMATION SYSTEM APPLICABLE TO THE HIGHWAYS DEPARTMENT

In order to design an information system for the Highways Department in the United Kingdom it is necessary to study the cost accounting theories to chose the most adequate theory to be the basis of the suggested system. The following is a brief summary of the costing theories.

The total costing theory

According to this theory all the normal costs of running an enterprise should be charged in someway, or another, to all the units produced (1).

This technique, of which practically all the components were worked out by financial accountants is characterized on the one hand by the concept of historical cost and on the other by the principal of money. The total costing theory has been accepted by the more professionally minded accountants (1). Using this technique the cost element should be classified into direct and indirect costs; TERRILL and PATRICK define them as follows:

"Direct costs, those costs which can be traced directly to a job, a product, a cost centre, an operation, a department, or an operating division. Indirect costs, those costs which cannot be traced directly to a job, a product, a cost centre, an operation, a department or an operating division".

A M HEGAZY "New development in costing techniques as an aid to managerial control" (unpublished Ph.D. thesis, Birmingham University, England 1950) p. 16.

W A TERRILL & A W PATRICK" Cost accounting for Management" (New York, Holt, Rinehart & Winston Inc., 1965) p. 25.

As a result the total unit cost comprises both the direct and indirect costs. The total costing theory has advantages and disadvantages. The main advantages of the theory are:

- 1. Since production cannot be achieved without incurring the indirect costs, such costs are related to production, and the total costing theory attempts to make an allowance for this relationship.
- 2. Due allowance is made for indirect costs in stock valuations so that "fictitious" losses will not arise in a period where production is in excess of sales output.
- 3. The total costing theory is useful in the setting of long-term pricing policies because it does not ignore the indirect costs.

The main disadvantages of the total costing theory can be summarised in the following:

- Total cost obscures the true relationship between price, cost and volume, because it ignores the incidence of cost behaviour on unit cost
- 2. The unit total cost will rise or fall from one period to another according to changes in production level (4).
- 3. Total cost data obtained by the use of the total costing theory can be confusing to the manager who is concerned with fixing prices based on cost. This confusion arises from, (a) the variation in the amount of overheads absorbed by production when there are changes in the volume of production, and (b) the problem of over or under absorbed overheads when predetermined recovery rates are in use (5).

W WRIGHT. "Direct standard costs for decision making and control" (New York, McGraw-Hill Book Company, Inc., 1962) p. 8.

F C LAWRENCE & E N HUMPHREYS. "Marginal Costing" First Edition, (London, Macdonald & Evans. 1947) pp. 15-16.

J BATTY "Cost and management accounting for students" (London, Hinemann, 1968) p. 148.

- 4. Finished stock could well comprise a part of several months or even years production. Identical products may have many different total costs when in finished stock, and the valuation of the inventory will not be accurate because it contains period costs carried from one period to another (6).
- 5. Total cost is not a measure of performance, and only has significance as an expense calculation. The measure which management needs is not the complete cost in all circumstances, but partial costs, including only those factors which are significant for their specific purposes (7), these are sometimes called relevant costs.
- 6. The cost units are charges with costs which they have specifically generated and also costs which they have not generated.

Moreover, using total costing theory in the enterprise will lead to little use of the cost accounting information which is presented to management, because it does not present the information needed for cost control and decision making. It also does not allow the use of an efficient budgetary control system.

The direct costing theory

According to this theory only the direct manufacturing and distribution costs should be charged to the unit produced (8).

The cost elements, under this technique, are also classified into direct and indirect categories. Inventories should be charged with the direct manufacturing and distribution costs and the indirect cost should be charged to the profit and loss account. The supporters of this theory justify this procedure by the following argument (9): (a) the indirect costs are not one of the main elements necessary for production and (b) the

⁶ F C LAWRENCE & E N HUMPHREYS. op. cit., p. 21.

⁷ A M HEGAZY. op. cit., p. 59.

⁸ A M ABAEL-RAHIM. "Indirect Cost" Cairo, 1970 p. 136 Arabic Reference.

⁹ Ibid. pp.136-137.

application of the theory avoids the difficulty of allocating the indirect costs, and avoids its inaccuracy as a result of the variety of bases of applying the indirect costs to products. This will make the cost calculation easier and will keep the unit cost constant at the different levels of output. BALBA, recognized the limitation of this theory and gave the following disadvantages (10):

- The indirect manufacturing costs represent part of the production cost which should not be ignored when calculating the unit cost.
- 2. The difficulties of applying the indirect cost to products are not a good reason for not allocating it to the cost unit.
- 3. Ignoring the indirect cost completely will lead to untrue cost for the finished goods, which in turn will lead to a lower inventory valuation, which in turn will distort the income statement.
- 4. It is difficult to establish the relationship between price, cost and volume as this necessitates the calculation of variable costs which cover some of the "ignored" indirect costs.
- 5. Responsibility accounting cannot be used when using the direct costing theory in the enterprise, and this will lead to lack of control.
- 6. Direct costing theory does not allow the use of a flexible budget in the enterprise.

It is believed that this theory was presented and applied before the industrial revolution when indirect costs were not large, and the problem of applying the indirect costs to product was not significant (11).

¹⁰ M T BALBA, "Cost Accounting" (Cairo - 1968) pp. 140-140. (Arabic reference).

A M ABDEL-RAHIM "Indirect Cost" op. cit., p. 140.

The marginal costing theory

The first bulletin in marginal costing was written by J A HARRIS and published by the National Association of Cost Accountants in 1936 (12). It is known in the United States as "direct costing" this title may confuse the "marginal costing theory" with "the direct costing theory" discussed before; it also creates a confusion with the direct costs as a category, and to avoid this confusion it will be called "marginal costing". The Institute of Cost and Management Accountants define "marginal costing" as follows:

"A principle whereby marginal cost units are ascertained. Only variable costs are charged to cost units, the fixed costs attributable to a relevant period being written off in full against the contribution for the period." (13)

and define "marginal cost" as:

"Marginal cost is the amount at any given volume of output by which aggregate costs are changed if the volume of output is increased or decreased by one unit." (14)

The technique of marginal costing therefore needed the classification of cost elements into variable and fixed costs which have been defined by TERRILL and PATRICK:

"Variable costs, are those costs which tend to vary proportionally in total amount with changes in the activity in the function involved, fixed costs, are those costs which are constant in total amount regardless of changes in production volume within the limits of existing capacity of a function."(15)

HEGAZY presents three fundamental postulates as the bases of the development of the marginal concept or rather the classification of cost elements into variable and fixed costs. These postulates are namely:

FE LAWRANCE & E N HUMPHREYS "Marginal Costing" Second Edition (London, Macdonald & Evans, 1967) p. 32.

¹³INSTITUTE OF COST AND MANAGEMENT ACCOUNTANTS "Terminology of Management & Financial Accountancy" London, ICMA. 1974) p. 12.

INSTITUTE OF COST AND WORKS ACCOUNTANTS "A report on marginal costing" (London, Gee & Co. Ltd, 1961) p. 8.

W A TERRILL & A W PATRICK, op. cit., pp. 24-25.

¹⁶ A M HEGAZY. op. cit., pp. 62-63.

- 1. Cost variation with volume. This postulate assumes that in a short period there are two independent groups of cost elements: the first is variable cost which is the function of volume, and the second is fixed cost which is the function of time and/or managerial policy. In the long run all costs tend to be variable, either by policy and/or change of condition.
- Variable costs and their association with sales. According to this postulate, variable costs and sales have similar dimensions; this means that variable costs change in the same direction with the sales volume.
- 3. Thinking in terms of contribution margin. In situations where income is generated, the gross contribution margin is a rational approach which is also related to gross profit. It presents the contribution made by products towards the realisation of total net profit and the recovery of fixed costs.

The main characteristics of the marginal costing theory have been emphasized by DICKEY as the following (17).

- It is a method of recording and reporting. It requires a unique method of recording cost transactions as they take place.
- 2. It needs the separation of costs into variable and fixed components and these are recorded separately.
- 3. Variable costs are applied to products; they are charged to products at the appropriate points and follow the product through the inventory account, but variable distribution costs are normally chargeable to product at/or near the moment of sale, and these are not included in inventory values.
- 4. Fixed costs (including fixed factory overheads) are written off as period costs in the period in which they were incurred. They do not follow the inventories through the accounts.

¹⁷ R I DICKEY. "Accountants Cost Handbook" (New York, The Ronald

Press Company, 1967) p. 9-50.

Marginal costing theory like the other theories has its advantages and disadvantages. The principal advantages of the theory have been presented by a number of writers. BROWN and HOWARD present the advantage of using marginal costs in preparing cost statements. They cited:

"Management usually find it easier to understand marginal cost statement than those produced under total costing theory. This is particularly so in case of foremen who are given statements which are influenced by their action and not obscured by the allocation of fixed costs."(18)

They also present its advantage in planning and state:

"Marginal costing aids profit planning; data can be presented to management showing cost-volume-profit relationships. Useful aids such as break-even-charts and profit volume can be used to facilitate planning." (19)

The N.A.A. in their research series No. 23, present the advantage of marginal costing in the appraisal of product, and as a medium of control, they cited the following:

"Marginal income figures, facilitate relative appraisal of products territories, classes of customers and other segments of the business, without having the results obscured by allocation of joint fixed costs. Marginal costs tie in with such effective plans for cost control as standard costs and flexible budget. In fact, the flexible budget is an aspect of marginal costing"(20)

The advantage of marginal costing in decision making has been explained by the Institute of Cost and Management Accountants as the following:

"The recognition of the distinction between fixed and variable costs is likely to be particularly necessary in the provision of information which will be used as the basis for making decisions. This information will usually be required for

J L BROWN & L R HOWARD 'Principles of Management Accounting" (London, Macdonald & Evans, 1965) p. 234.

¹⁹ Ibid. p. 234.

N.A.A.BULLETIN "Direct Costing" N.A.A. Research Series No. 23 Vol. 34 as cited by R I DICKEY op. cit., p. 9.73.

specific purposes and will be prepared in the form appropriate to the particular circumstances. It is most conveniently provided as the result of ad hoc investigation which aims to distinguish between fixed and variable costs to the extent to which they are likely to have significance in those particular circumstances other management problems where logical decisions can materially be facilitated if the information is prepared in the form of showing marginal costs are; the allocation of orders between factories, the selection of economic manufacturing equipment...., and the economic feasibility of major projects."(21)

Another advantage of marginal costing is that it facilitates the use of responsibility accounting in the enterprise. WRIGHT states "Marginal costing establishes clear-cut responsibility accounting" (22) and TERRILL and PATRICK explain this as follows:

"Current control of costs requires that cost within functional areas of responsibility be identified as to their fixed and variable characteristics in the short run. This separation is a prerequisite of marginal costing and is reflected in all marginal costing statements prepared for management. The identification of variable costs, and in most cases of controllable costs aids the person immediately responsible for controlling those costs to detect excesses and take corrective action. It also aids higher level supervisory personnel in evaluating the performance of men responsible to them" (23)

Marginal costing also has its advantage in facilitating communication within the enterprise, HALFORD states:

"Marginal costing leads to better communication, and less analysis is needed to explain the financial terms with a considerable saving in executives' time." (24)

Another advantage claimed for marginal costing is connected with stock valuation and the calculation of profit, BATTY states:

²¹ INSTITUTE OF COST AND WORKS ACCOUNTANTS "A report in marginal costing" Op. cit., p. 11.

²² w WRIGHT. op. cit., p. 210.

²³ W A TERRILL & A W PATRICK op. cit., p. 520.

DRCHALFORD "A case of marginal costing" The Manager, June 1961, p. 457.

"The exclusion of fixed overhead costs from stock valuation and the writing off of the fixed costs within the period in which they are incurred tend towards greater accuracy in both stock and profit figures."(25)

The disadvantages of marginal costing theory have also been presented. One of the marginal costing theory disadvantages, when employed in an enterprise with more than one product, is the impossibility of calculating the net profit for each product, BROWN and HOWARD explain that by stating:

"If a system of marginal costing is operated in an organisation with more than one product, it will not be possible to ascertain the net profit per product because the fixed overheads are charged in total to the profit and loss account, rather than recovered in product costs." (26)

Another disadvantage is that some accountants question the acceptability of marginal costing as a basis for costing inventories in financial statements presented to the stockholders and to the public at large. (27) The Institute of Cost and Management Accounts explain the circumstances when such a question is valid by stating:

"There are circumstances, however, when the exclusion of fixed costs from stock valuation cannot be readily justified
In industries such as shipbuilding or contracting, where the unit of sale is large and the value of work in progress is high in relation to turnover, the value of fixed costs applicable to work in progress may vary widely from year to year according to the volume of work in progress. In these circumstances it may be desirable to include fixed costs or a proportion of them in the stock valuation, and so avoid distortion of the financial results by showing unduly high profit during periods in which jobs have been finished and work in progress reduced, or unduly low profit during periods in which work in progress has been increased." (28)

The N.A.A. refer to the income tax problems which may be encountered if a change is made from full cost to marginal cost, for costing inventory as, a result of lack of definite rules for guidance, as a disadvantage of marginal costing. (29)

²⁵ J BATTY, op. cit., p. 148.

J L BROWN & L R HOWARD, op. cit., p. 221.

²⁷ N.A.A. "<u>Direct Costing</u>" <u>op. cit.</u>, p. 9-73.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS. "A report on marginal costing" op. cit., p. 21.

BATTY, claims that "the difficulties created by having to separate semi variable costs into their fixed and variable elements", (30) and "the existence of the apportionment of variable overheads problem is another disadvantage of marginal costing. (31)

In situations where income is generated, marginal costing has its limitation in long term pricing especially in case of an enterprise producing more than one product; the Institute of Cost and Management Accountants states:

"Short term decisions in respect of selling prices, that is divisions made using marginal costs as a basis, should remain short term and only for the specific circumstances which caused the decision to be made. It is obvious that if profits are not to be made over the long term selling price must yield a total contribution which will always exceed fixed overheads." (32)

In reviewing these disadvantages, we find that the inaccurate classification and separation of semi-variable cost into their fixed and variable element by using one of the statistical methods has usually resulted from careless analysis of the basic behaviour patterns. The unhappiness associated with marginal costing in financial statements has been countered by The Institute of Chartered Accountants in 1960, they state:

"Where, however, the level of production or sales are subject to material fluctuation and are not kept in balance. It may be decided to exclude these (period) expenses from stock on the grounds that their inclusion in the stock has the effect of reliving the profit and loss account in period when they are incurred, of expenses it should fairly bear, and of charging these expenses in a later period to which they do not properly relate."(33)

These words are a positive invitation to the use of marginal costing in financial statements. On the tax side, some favourable rules have been

³⁰ J BATTY, op. cit., p. 145

³¹ Ibid. p.145.

INSTITUTE OF COSTS AND WORKS ACCOUNTANTS "A report on marginal costing" op. cit., p. 21.

THE INSTITUTE OF CHARTERED ACCOUNTANTS IN ENGLAND AND WALES "Accounting Principles No. 22" November 1960. p. 3.

made in the United States. The Treasury Department held that period costs for idle plant could be written-off each period. This was an agreement of the department to the use of marginal costing. (34)

Management also accept the use of marginal costing to fulfil its purposes. (35)

The absorption costing theory

The total costing theory previously described is sometimes called the absorption costing theory. (36) There are two differences between the two theories, 1) the total costing theory classifies the cost element into direct and indirect costs, and the absorption costing theory classifies them into variable and fixed costs, 2) the total costing theory charges the product, in someway or another, with all normal costs, and the absorption costing theory charges the product with the variable costs, plus that portion of the fixed costs which the volume of production utilized bears to the attainable capacity.

The absorption costing theory is, in one way, an extension of the marginal costing theory. The differences between these two theories is based on the allocation of fixed costs to the product. There exist two assumptions of the ways of treating fixed costs. (37)

- The deduction of total fixed cost, for the whole enterprise, from the composite figure of individual contributions. This leads to the marginal costing theory.
- 2. The allocation of fixed costs to the product unit on some fair and equitable basis which is the level of capacity used in producing the product. This leads to the absorption costing theory.

³⁴ W WRIGHT, op. cit., p. 215.

D H LI. "Cost accounting for management applications" (Columbus, Ohio, Charles E Merrill Books inc., 1966) pp. 202-205.

Sometimes called "capacity costing" see, R K JONES "Why not capacity costing" N.A.A. Bulletin Vol. 39, No. 1, November 1957, p. 14.

³⁷ A M HEGAZY op. cit., p. 63.

The use of absorption costing theory in an enterprise requires the determination of normal capacity, and the level of capacity and the actual capacity used in producing each product which should be the basis for allocating fixed costs. The unallocated cost, which is the liability of the idle capacity, should be charged in total to the profit and loss account.

The absorption costing theory has the same advantages as the marginal costing theory, and assists in avoiding some of the marginal costing disadvantages. It does not ignore the fixed cost completely, thus avoiding the difficulty of ascertaining the net profit per product in an enterprise with more than one product. It also eases the determination of the total cost for each product which does not contain any idle capacity cost; this should help in fixing the selling prices of products. Absorption costing theory has an additional advantage, it helps management in defining the idle capacity and its cost, and this should lead to studying its cause and taking the necessary corrective action.

The absorption costing theory does have its disadvantages which are:

- 1. It is difficult to establish the level of capacity and its unit of measurement in different firms.
- 2. The theory leads to a combination of product and period costs, and allows the period costs to be carried over in inventory to another period.

The first disadvantage can be solved by the assistance of engineers and the introduction of workstudy in the enterprises, and the second disadvantage is in fact the ideal solution for valuating inventory in industries such as shipbuilding and contracting, and for other types of industry it will be easy to value the inventory on the marginal costing basis.

The information system applicable in the Highways Departments

A management information system has been defined by GILLESPIE, as follows:

"A management information system is a system for storing (in some situations), manipulating and reporting as required the information needed for making programmed decisions. It is concerned with day to day operation decisions, and with short and long term planning decisions, as distinguished from decisions

for strategic planning (which may be short term or long term)". (38)

In the Highways Department the suggested information system, which is needed to help the different levels of management in decision making should consist of:

- 1. cost unit, cost centres, and cost element codes
- 2. cost accounting records
- 3. budgetary control system
- 4. reporting system, and
- 5. flow of documents which explain the relation between the prime documents and the components of the information system.

The information system should be an integrated system and should be designed according to the enterprise objectives. The information system should be able to present all types of information needed by the different levels of management and which should help in planning, controlling an decision making. The system should also be based on one of the above mentioned costing theories.

The Highway Department is one of the County Council departments which is responsible for maintaining and improving the county roads. Its task is to provide services to the community, and therefore is not concerned with profit. The Highways Department may act as an agent for the Department of the Environment in maintaining the motorways and the trunk roads within the county borders and may also carry out private work for the public; in these cases the Highways Department should charge them with the full cost of the finished work. The information system should provide the different level of management with the information which will help them in planning and controlling the cost of the maintenance and improvement work of the county roads, and in charging the outside parties with the cost of their work. The system should identify the deviations from expectation and indicate the person or cause responsible.

C GILLESPIE "Accounting Systems Procedures and Methods" (N-J, Prentice-Hall, inc., Englewood Cliffs, 1971) p. 614.

³⁹ REPORT OF THE COMMITTEE ON HIGHWAY MAINTENANCE Op.cit., p.182.

The Highways Department is a direct labour organisation. This means that it has its permanent labour force which deals with the improvement and maintenance work, but in, some cases, it may employ temporary labour for short periods to carry out special types of work, or it may rely upon a contractor to carry out some jobs when the load of work in the department is above its normal capacity or if there is a need for skilled labour and special type of plant.

Because of these objectives and the circumstances of the Highways
Department, it is suggested that the marginal costing theory should be
the basis of the information system, because of its advantages in
providing management with the information which is required for planning
and control. These advanatages are, essentially, that it allows the
previous of relevant information for so many different purposes, for
example:

- 1. The use of marginal costing should facilitate the preparation of the operational flexible budgets on the basis of physical factors. This should help in exercising better control over the work carried out by the department.
- 2. The use of marginal costing should permit the development of responsibility accounting, each manager receiving relevant information on costs within his control.
- 3. The use of marginal costing will provide information which should help managers in decision making in different areas, for example, the use of the County Council plant or hiring it, where it is important to establish what are the relevant costs for comparison purposes.

The use of marginal costing, as the basis for the information system is not difficult because it is easy to identify the cost unit – job or operation – and to allocate the cost elements which are used to the appropriate cost unit. The classification of the cost elements into variable and fixed costs as marginal costing theory requires is more apparent. (40) This classification should be carried out with the aid

J B GOODLAD "Marginal costing in construction industry" Management Accounting Vol. 51. No: 1 January 1973. p. 7.

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of the "cost variation of volume postulate", mentioned before. According to this postulate, the variable cost elements should be those cost elements which have a direct relationship with the cost unit or the cost centre, and are easy to identify, and vary in the same direction with the production volume. Fixed costs are those costs which have no direct relation with the cost unit and/or the cost centres, and the production volume. (41)

The variable and fixed costs will be defined in the Highways Department as the following:-

Variable costs, are those costs which have a direct relationship with the volume of the cost unit or the production of the cost centres. These costs should vary in the same direction as the volume of production. It covers the direct material, labour, and plant which relate directly to the improvement and maintenance work, and other costs which vary with the volume of cost units. The total cost of the work carried out by contractors should also be treated as a variable cost as there is a relation between the cost and the volume of work carried out by the contractor. The same approach will be used with the cost centres.

There are a number of methods which are usually used in separating the cost element into variable and fixed costs. These methods are:-

A. The analytical method

B. The high-low method

C. Scattergraph method.

D. The least squares method

A full description of each of these methods can be found in a number of costing text books for example.

⁻ J DEARDEN. "Cost Accounting and Financial Control Systems" (London, Addison Wesley Publishing Company 1973). pp. 208-210.

⁻ J H LI. op. cit., pp 600-603.

⁻ W A TERRILL & A W PATRICK, op. cit., pp. 340-343 and 373-376.

Fixed costs are those costs which have no direct relationship with the cost unit and do not vary with the production volume in the cost centres i.e. administration costs.

According to the marginal costing theory the cost unit and the cost centre should be charged with the variable costs only, and it is recommended that the absorption costing theory should be used in calculating the full cost of the outside parties work. The use of absorption costing theory will not require any changes in the basic costing system.

In the following chapters, the suggested information system will be described in detail.

CHAPTER 3

THE CODING SYSTEM FOR THE HIGHWAYS DEPARTMENT

In this chapter the coding system which is the first part of the suggested information system will be described in the following manner.

Section One: A theoretical survey of coding methods

and their application in the Highways

Department.

Section Two: The cost units and cost centre codes for

the Highways Department.

Section Three: The cost elements codes for the Highways

Department.

SECTION ONE

A theoretical survey of coding methods and its application in the Highways Department

Classification and coding are two basic and important elements of management information system: DANILES and YEATES define classification as the following.

"The systematic arrangement of all items within the system, so that like items are grouped together."(1)

The N.A.A. define it as:-

"The identification of each item and the systematic placement of like items together according to their common features. Items grouped together under common heads are further defined according to their fundamental differences."(2)

RISK mentioned that,

"The term classification may also be used to indicate a number of items which have been classified in the sequence prescribed by the classifying process." $\ensuremath{^{(3)}}$

Classification is the first step towards preparing the coding system. GILLESPIE, explains that through his definition of coding, he states:-

"Coding is a plan by which numbers or letters of the alphabet (or a combination of numbers and letters) can be assigned to a previously arranged classification. Codes are a convenient device for identifying and distinguishing the items in a classification."(4)

A DANILES and D YEATES, Editors "Basic Training in System Analysis" Second Edition (London Pitman Publishing Company) p.85.

N A A "Classification and Coding Techniques to Facilitate Accounting Operations" N.A.A. Research Series No. 34, April 1959. p3.

J M S RISK "The Classification and Coding of Accounts" (London, The Institute of Cost and Works Accountants. 1967) p.17.

C GILLESPIE. op.cit., p.48.

On the other hand, RISK explains the difference between the terms "coding" and "code" by giving the following definition:

"Coding may be defined as the act of referring any item to the classification in which it lies, ascertaining the position of the item in the classification, and ascribing to the item the symbols already assigned to the position occupied by the item in the whole classification. A code may be defined as a system of symbolic representation of items of information designed to facilitate the transmission of such information between people familiar with the system."(5)

LADEN and GILDERSLEEVE, mentioned that the code should incorporate certain characteristics which are summarized as follows. (6)

- 1. Flexibility; codes must provide for an expansion of entries within categories which take either the form of tail-end expansion or interspersed expansion.
- Scope. The design of a code should cover all uses to which the code will be put.
- 3. Operation. The code selected must be adequate for all operations for which it is used.
- 4. Convenience. The code should be easy to assign, write, transcribe, and to check. The code should contain a fixed number of digits to simplify its use.
- 5. Uniqueness. The code must distinguish each unit, cost centre, or element clearly.
- 6. Identification. The code should facilitate visual identification of an item.

There exist four methods of symbols which may be used for coding the classified items, each having its advantages and disadvantages.

J M S RISK op.cit., pp.17-18

H N LADEN and T R GILDERSLEEVE "System Design for Computer Application" Fifth printing (New York, John Wiley & Sons, inc., 1967) pp.188-190.

- 1. The first method uses alphabetical symbols to code the classified data. The principal advantages claimed to this method are: (7)
 - A More classifications can be denoted with a single position. This means that there are twenty-six alphabetical symbols available for coding.
 - B Alphabetical symbols can be designed to suggest names of the item identified.

The limitation of this method is that it becomes cumbersome when lengthy symbols are needed. For this reason, alphabetic symbols are used only when a few letters suffice. (8)

- 2. The second method employs numbers for coding. This method, in turn, codes the classified data according to one of the following types of codes.
 - 2.1 Sequence codes. These codes are utilized by assigning numbers in numerical order to items under classification; this system is sometimes referred to as "straight numbering" (9) or "serial numbering". The limitation of this type of coding has been given by N.A.A. and RISK. The N.A.A. state:

"Sequence coding provides only one basis of classification, and so long as numerical sequence is maintained, items can be added only at the end of the list."(11)

N.A.A. "Classification and coding techniques to facilitate accounting operations" Op.cit., p.7

^{8 &}lt;u>Ibid.</u> p8

⁹ R I DICKEY, Op.cit., p.2.19

J M S RISK, Op.cit., p 29

N.A.A. "Classification and coding techniques to facilitate accounting operations" Op.cit., p. 10

and RISK states:

"One of the defects of serial numbering is that new items tend to be added without sufficient care being taken to ensure that a number does not already exist for the unit being added to the code."(12)

2.2 <u>Block codes</u>. This type of coding is designed by reserving blocks of numbers in sequence for each classification of items to be coded. DICKEY mentioned that:

"Block code remedies the basic deficiency of sequence codes. It permits numeric coding of a predetermined classification but allows for expansion in the number of items within each classification."(14)

RISK explains its main disadvantage by stating:

"As regards the class block type of code, the main danger is that future development may not have been carefully anticipated, with the result that certain blocks fill up too rapidly. It then happens that subsequent items cannot be assigned to the correct block, and have to be inserted haphazardly within blocks relating to a different type of item." (15)

2.3 Group codes. Group codes are similar to block codes except that they allow for almost unlimited sub-division of classification by means of positioning digits. The first digit in a code number represents the major classification; the second represents the secondary classification, etc.

It is sometimes referred to as "progressive codes". (17)

J M S RISK, Op.cit., p.29

N.A.A. "Classification and coding techniques to facilitate accounting operations" Op.cit., p.10.

R I DICKEY. Op.cit., p.220

J M S RISK. Op.cit., p.30

R I DICKEY. Op.cit., p.220

J M S RISK. Op.cit., p.30

GILLESPIE, mentioned that the following points may be made concerning group classification codes:-

- "1. They aid memory of the user to some extent, because users quickly learn the significance of digit position in the code.
- 2. Group classification codes tend to compromise more digits than block or sequence classification codes, but fewer than other codes.
- 3. Group classification codes provide for expansion of main classes by leaving unassigned numbers in the original list. They do not provide for infinite subdivision, since the number of digit positions is definitely fixed.
- 4. They identify each item in the code with all superior groups to which the item belongs." (18)

RISK mentioned that this type of code is a useful method of symbolization for practical purposes, especially when the code contains a large number of items of widely differing attributes. (19)

2.4 <u>Decimal codes</u>. The decimal coding system is an extension of group coding. This type of coding provides almost unlimited sub-division of a major classification.

The decimal coding to the left of the decimal point is the same as in group coding. The decimal point comes into play to divide and sub-divide within a group.

¹⁸ C GILLESPIE. Op.cit., p.51

¹⁹ J M S RISK. Op.cit., p.31

R I DICKEY. Op.cit., p.51

²¹ H N LADEN and T R GILDERSLEEVE, Op.cit., p.195

RISK gave the following limitation of this method, he states:

"This method is very suitable for the coding of costing and other accounting activities, but where the range of attributes to be coded is large, it may be found that the length of the appropriate decimal code is too great for practical purposes." (22)

2.5 Chain code. This classifies each feature within the classification according to its own code. RISK presents the following example to illustrate this description.

"An article may be defined by length, height, width, colour, finish, quality, and type of material. Minor code systems can be developed for each feature, and for any one article all the minor code numbers are strung together in a chain, being separated by points, abliques or dashes." (23)

This method allows the integration of one with another. This can be achieved by transplanting the appropriate section of the code with the other code, and it is also useful when it is useful and/or desirable to reveal the different attributes of the classified features, However, this method is not the most suitable form of coding from the clerical point of view.

3. The third method employs both alphabetical and numerical letters in symbolizing the classified features. LADEN and GILDERSLEEVE mentioned that the advantages of using this method are, more classification can be denoted in a position than can be expressed in alphabetic codes, and codes of this type aid the memory of the person using them. (25)

J M S RISK. Op.cit., p.32

^{23 &}lt;u>Ibid</u>. p.32

²⁴ J M S RISK. Op.cit., p.32-33

²⁵ H N LADEN and T R GILDERSLEEVE. Op.cit., p.202

On the other hand, RISK explains the scope of using this method by stating the following:

"In a very large population, and merely for identification purposes at rare intervals, a combined alphabetical-numerical system may have advantages, but for industrial and commercial purposes this type of symbolization is not of such great value." (26)

4. The last method of symbolization is the use of pictorial and other symbols for coding the classified features. This method is not in great use in the field of accountancy. (27)

Before attemtpting to suggest in detail the coding system for the Highways Department, it is necessary to review the purposes for which such a system is required. It is also necessary to consider: the nature of the work in the department, the nature of information which is needed for the different levels of management, and the ability of persons who will use the code.

The structure of the Highways Department Code

The purpose of a coding system in the Highways Department is to provide a basis for classifying, recording, and reporting all types of information needed for different purposes. The main task of the department is to maintain and improve the roads within the local authority border. The cost elements which are needed for this type of work consist of material, labour, and plant, and each of these elements is divided into a number of groups. The different levels of management need different types of information to help them in decision making, and this information should be presented to them according to their responsibilities and authority to take action. The prime document, which is the basis for the information system, is most likely

²⁶ J M S RISK. Op.cit., p.13

²⁷ Ibid. p.23

originated in the field by persons who have received little theoretical training in management; it is therefore essential that any coding system should be simple enough for rapid understanding by those persons who will be allocating material quantities, labour hours, and plant hours against the individual code.

The framework of the suggested code in the Highways Department, for cost accounting purposes should cover the following:-

- 1. A code for the different types of road within the local authority border to distinguish between the different categories of roads.
- 2. A code for the cost units which represent the different maintenance and improvement work. This should facilitate: the use of budgetary control, the calculation of the cost of each operation throughout the county, and the comparison between the cost of the same operation in different categories of roads.
- 3. A code for the different cost centres which should be used as an intermediate point to which expenditure is charged for the later distribution, if necessary, to the cost unit.
- 4. A code for the cost element which is needed for the work in maintenance and improvement work, and in the different cost centres. This should facilitate the allocation of cost elements, the comparisons between actual and predetermined costs, and in preparing the operational budgets.

The group method of coding should be the basis for the suggested codes because of its advantages and its suitability to cope with the Highways Department circumstances.

The suggested road categories code, the cost unit code, and the cost centres code will be described in Section Two, and the cost element code will be described in Section Three.

SECTION TWO

The cost units and cost centres code for the Highway Department

The traditional method of calculating the cost of a construction work is by using the contract costing method. In this case the cost unit should be the whole contract. This method of costing has its limitations in planning and in controlling the construction work, as the contract usually consists of a number of operations which may follow each other, or which may be carried out in the same time, and there is a need for information which should help in controlling the work and in taking corrective action throughout the work. This necessitates the breakdown of the contract into a number of cost units, each representing a complete operation of the contract. A budget should be prepared for each operation and the actual cost of the finished work should be compared with the budget and deviations reported to the responsible manager to take corrective action.

The Highways Department is responsible for maintaining and improving the county roads in the rural areas, and which are designated by the Department of the Environment as "classified roads" in the non-county borough and urban district areas. It also carries out the improvement and maintenance work of trunk roads and motorways within its borders as a contractor for the Department of the Environment which pays the cost of the finished work.

The county roads have their own classification letter and position numbers, therefore there is no need to suggest another code to be used to identify each category of roads; it is believed that the separation between each category of roads within the county border does not present any problem.

The maintenance and improvement work should be divided into a number of cost units, each representing an operation which may take place

²⁸ K J EDDEY. "An outline of Local Government Law" (London, Butterworth & Co. 1969) pp.97-98

separately or as a part of project, and which may take place in any category of roads.

The Institute of Cost and Management Accountants define cost units as

"a quantitative unit of product or service in relation to which costs are ascertained."(29)

The maintenance work operations

Local authorities must keep their public highways in good condition to accommodate the ordinary traffic which passes, or may be expected to pass along them. This necessitates the need for regular maintenance. Maintenance standards adopted by Highways Department were generally ill-defined and varied from one authority to another according to the judgement of the County Surveyor and the funds available till the introduction of the "Marshall Report". The report presents the first set of defined maintenance standards needed for the different types of maintenance operations. (30)

It is suggested that the maintenace operations presented by the "Marshall Report" should represent the maintenance cost units. The Marshall Report breaks down maintenance operations into groups, each representing one of the main maintenance functions, and each of the latter is also divided into a number of operations. Maintenance works therefore have been coded under main group code number (1), and each of its groups has been coded by using the second digit, and each of the group's operations has been coded by using the third digit of the code. The framework of the maintenance operation's "cost units" therefore should be within the following framework.

Institute of Cost and Management Accountants "Terminology of Management & Financial Accountancy" Op.cit., p.21.

Report of the Committee on Highway Maintenance. Op.cit., pp.106-128

Main Group Code No	Sub-Group Code No	Operations "cost units" Code No.	Description
1		:	Maintenance operations
	11		Structural maintenance
		111	Surface dressing
		112	Patching
		•	
		118	Gully emptying & mainten- ance of drainage systems
	12	i	Aid to movement
		121	Snow & ice clearance
		•	
		•	
		127	Maintenance of road lighting
	13		Amenity functions
		131	Grass, tree & hedge cutting
		132	Sweeping & cleaning

The improvement work operations

A local authority has the power to improve highways within its border. Improvement of existing county highways, trunk roads, and motorways are the responsibility of the Highways Department which may carry out the work by using its direct labour force or by using contractors. The improvement work covers the structural work, and aid to movement work required to improve an existing highway. The Department of the Environment has introduced methods of measurement for road works.

This measurement has been used as the basis for identifying the improvement work operations' "cost units" which the improvement work

DEPARTMENT OF THE ENVIRONMENT "Method of measurement for road and bridge works" (London, Her Majesty's Stationery Office, 1971)

pp.13-62

may consist of. The improvement operations "cost units" have been coded under main group (2), and the structural operations and aid-to-movement operations have been coded under sub-groups 21 and 22 respectively. Each of the latter has been divided into a number of operations which may be included in an improvement project. The framework of the improvement work code should be as follows.

Main Group Code No	Sub-Group Code No	Operations "cost units" Code No.	Description
2			Improvement operations
	2 1/22		Structural operations
		211	Preliminaries
		212	Site clearance
		•	
		•	
		• 221	Footway paving & kerbing
	23		Aid to movement operat- ions
		231	Traffic signs & road marking
		232	Road lighting

The Highways Department Cost Centres

The Institute of Cost and Management Accountants define the cost centres as

"A location, person or item of equipment (or group of these) in respect of which costs may be ascertained and related to cost units." (32)

and define service cost centres as

"A cost centre for the provision of a service or a service to other cost centres." (33)

Institute of Cost and Management Accountants "Terminology of Management and Financial Accountancy" Op.cit., p.21.

³³ Ibid. p.21.

In the suggested information system for the Highways Department both types of cost centres will be used; plant cost centres respresenting the different types of the County Council owned plant, administration cost centres representing the different locations of the administration offices within the department, and service costs centres representing workshops and laboratories in the central repair depot, divisional depots, and central laboratories.

1. The plant cost centres

Plant cost centres should be used as intermediate points to which costs are charged in order to calculate the cost per hour or day for each type of plant which may be used in carrying out the maintenance and improvement work.

It is suggested that the County Council plant should be divided into groups according to their types; this should then be divided into a number of cost centres each representing similar items of plant. The plant cost may represent an individual unit or more according to the number of items owned by the County Council. Plant cost centres represent the third main group of cost units and cost centre codes; therefore it has been coded under the main code (3) the second digit of the code represents a main group of plant, the third digit the different types of plant, and the fourth digit the different plant cost centres. The framework of this main code - 3 plant cost centres - should be as follows:-

Main Code No.	Sub Code No.	Main group Code No.	Cost Centre Code No.	Description
3	31			Plant cost centre
		311		Vans
		312		Lorries
			3121	3 ton Diesel Lorries
			3122	3 ton Petrol Lorries
			:	:
			3128	7 ton Petrol Lorries
		313		Special Gritter Lorries
		319		Trailers
	32			Construction Plant
		312		Excavators and Shovels
			3211	Excavators
			3212	Loading Shovels
		322		Surfacing Plant
		•		:
		329		Miscellaneous construction plant
	33			Special purpose plant
		331		Gritting Machines

NB. In the case of a main group with only one cost centre, it is suggested that "zero" should be the fourth digit.

The administration cost centre

The administration cost centres in the Highways Department may be located: in the County Council building, in the divisions, in the central repair depot, and in the central laboratory. Each of these locations should represent a cost centre, therefore, it has been coded under main code 4. This main code has been divided into a number of sub-codes, each representing one of these locations; As there are a number of divisions in the Highways Department, its sub-code has been divided into a number of cost centres, each representing one of these divisions. In order to maintain the significance of the digit position in the code, it is recommended that a "zero" should be added as the third digit, to represent the administration cost centres in the other locations, each of which represents a cost centre. The framework of this main code should be as follows:

Main Code No.	Location sub-code No.	Cost Centre Code No.	Description
4			Administration cost centres
	41	410	Head Office
	42	420	Central Repair Depot Office
	43	430	Central Laboratory Office
	44		Divisional Administration Offices
		441	Division one

NB. Location 44 Divisions, should be divided into a number of cost centres according to the number of administration offices in the divisions.

The service cost centres

The service cost centres represent the specialized workshops in the central repair depot which deal with a specific type of repair, and the specialised laboratories in the central laboratory, also the divisional

workshop and laboratory should be represented by a service cost centre. Service cost centres has been coded under main code 5, which has been divided into a number of sub-codes each representing a location of these service cost centres, and the latter has been divided into the appropriate service cost centres in this location. The framework of this main code should be as follows:

Main Code	Location Sub-code	Cost Centre Code No.	Description
5	51	511 512 :	Service cost centres Central Repair Depot Maintenance Workshop Engine Repair Workshop
	52 53 54		Divisional Workshops Central Laboratory Divisional Laboratories

- NB. 1. The number of services cost centres in the central repair depot, and in the central laboratory should depend upon the organisation structure of each of them.
 - 2. The number of divisional cost centres should depend upon the existing workshops and laboratories in the Highways Department divisions.

The framework of the cost units and cost centres codes

The cost units and cost centres code which has been suggested for the Highways Department can be summarised as follows:-

Main Code	Sub Code	Main Group Code No.	Cost Unit Cost Centre	Description
1				Maintenance Operations
	11			Structural maintenance
			111	Surface dressing
			112	Patching
0				
2		:		Improvement operations
	21/22			Structural operations
			211	Preliminaries
			212	Site clearance
3				Plant cost centres
	32			Vehicles
	0.1	311		Vans
		312		Lorries
	32			Construction plant
	-	321		Excavators and shovels
. 4				Adminstration cost centres
	41		410	Head Office
	42		420	Central repair depot
5				Service cost centres
	51			Central repair depot
			511	Maintenance workshop
			512	Engine workshop

NB. Main group code had been introduced in main code 3 plant only and therefore the plant cost centres symbols consist of four digits instead of three, for the remainder of the cost units and cost centres symbols.

A complete description of the cost units and cost centre code is described in Appendix 2.

SECTION THREE

The cost elements codes for the Highways Department

Marginal costing theory, which has been chosen to be the basis of the information system, requires the classification of cost elements into variable and fixed costs, therefore, the cost elements have been classified to fulfil this requirement.

The cost elements have been divided into six main groups; the first five groups cover the variable elements whereas the last covers the fixed elements. These main groups have been coded under the main codes 1 to 6 in the following manner:

Main Code No.	
The second state of the second control of the second secon	Variable elements
1	Materials
2	Labour
3	Plant
4	Expenses
5	Contractor works
6	Fixed elements

The classification and coding of cost elements under these main codes necessitates the use of five digit codes which may - if needed - expand to six digit codes to allow more detailed information. A comprehensive list of cost element codes is described in Appendix 3, and the following is a summary of the framework of this code.

Main Code l Materials

All types of materials which are used in the Highways Department and which vary with the volume of the cost units and the load of work in the service cost centres have been classified under this main code.

The second digit of this main code represents the type of work for which the materials are usually used, the third digit represents the nature of materials, the fourth represents a different quality of materials, and the fifth digit represents the cost element code number. In some cases

cases, a sixth digit has been used to represent the cost element; this code only being used when there are different sizes of the cost element. The following table represents the framework of this main code.

Main Code No.	Sub Code No.	Main Group Code No.	Group Code No.	Cost Element Code No.	Description
1					Materials
	11/12				Construction materials
		111/112			Dry materials
			1111		Slag
				11111	152mm - 228mm slag lump
				11112	76mm - 102mm slag rejects
				11113	38mm - 64mm slag rejects
				•	
				11117	6mm slag chips
			1112	1	Granite
		•	1113		Limestone
			•		
			1125		Plastic Material
		113			Pre-coated materials
		114			Pre-mixed materials
		•			
		123			Waterproof under sheeting
	13				Drainage materials
	14				Aid to movement materials
	15				Miscellaneous materials
	16				Special purpose materials
	19				Haulage of materials

An example of using a six digit code to represent the cost element code can be demonstrated in the following:

Main Group	Group Code	Cost element	Cost Element	Description
Code No.	No.	Code No.	Code No.	
143	1431	14311	143111 143111	Street lighting Lamps Fluorescent lamps 6w 200mm standard fluorescent 8w 300mm standard fluorescent

In this case it is possible to use the cost element code No. 14311 to represent all sizes of fluorescent lamps, but if more details are needed the six digit code should be used.

Main Code 2 Labour

This code represents the workers who are involved in carrying out the improvement work, the maintenance work, and the work in the service cost centres. The second digit of the code represents their category and working terms with the County Council, the third digit represents the different types of payment, the fourth represents the components of payments, and the fifth digit represents analysis of these components. The cost unit code should consist of a five digit code, and when the type of payment or its component represents the cost element a number of ("zero") should be added to complete the five digit code. A summary of the suggested classification of this main code can be demonstrated as follows:

Main Code No.	Sub Code No.	Main Group Code No.	Sub- code Code No.	Cost element Code No.	Description
2					Labour
	21				Permanent Roadmen.
		211			Wages
			2111		Basic payment
				21111	Working time
				21112	Travelling time
			2112		Idle time
				21121	Bad weather
				21122	Breakdown of plant
			and the second	•	
				077.04	Lack of equipment
				21124	Lack of equipment
			2113		Overtime payment
			2110	21131	Normal rate
				•	
				•	
				21134	Double rate
					Pagus paymont
		212		21200	Bonus payment
*		213			Employment cost (County Council contribution)
			2131	21310	National health insurance
			2132	21320	Graduated National Insurance pensions
			2133	21330	Superannuation
	22				TEMPORARY ROADMEN
	23				PERMANENT DRIVERS and PLANT OPERATORS
	24				TEMPORARY DRIVERS and PLANT OPERATORS
	25				DRIVERS and PLANT OPERATORS FOR HIRED PLANT
And the second s	26				FITTERS
	27				TECHNICIANS
	21				

Main Code 3 Plant

The third major element required for carrying out improvement and maintenance operations is plant. The costs of using the County Council plant or hired plant are classified under this main group; this cost does not include the drivers or the plant operators' costs, - these costs should be coded according to the appropriate code under main code 2 "labour", this necessitates that the rate per day or per hour which should be calculated for each plant cost centre should represent the cost of using the item of plant, and the rate per day, or hour, for the hired plant should be determined separately from the drivers' or plant operators' rate.

The cost elements representing the plant cost have been classified in the same manner as the plant cost centres, as they represent the allocated costs of these cost units, therefore the second digit of this code represents the different groups of plant, the third digit representing the different types of plant, the fourth digit representing two possibilities of the plant source - County Council plant or hired plant - and the fifth and the last digit of the code represents the cost of using an item of plant in the operations - the cost element. As a result of classifying the plant cost elements in the same manner as the plant cost centres, the first three digits of the plant cost elements code are similar to the plant cost centre code, and the fifth digit of the plant cost elements code are also the same as the fourth digit in the plant cost centres code. The framework of this main code is as follows:

1			_		
Main Code No.	Sub Code No.	Main Group Code No.	Sub Group Code No.	Cost element Code No.	Description
3	31 32 33	311 312 313 319	3121	31211 31212 31212 31212	Plant Vehicles Vans Lorries County Council Lorries 3 Ton Diesel Lorries 3 Ton Petrol Lorries Hired Lorries 3 Ton Diesel Lorries 3 Ton Diesel Lorries 3 Ton Petrol Lorries Special gritter lorries Trailers Construction plant Special purpose plant

Main Code 4 Expenses

This main code represents the variable expenses which are needed for the maintenance and improvement projects, the plant cost centres, and the service cost centres. It is divided into three main groups, each representing the location of these expenses; this is then divided into the different types of expenses required. As a result of this classification, three digits are used and, in order to keep the significance of digit position, it is suggested that two "zeros" should be added to present a five digit code representing each item of expense as a cost element.

Main Code 5 Contractor Work

The Highways Department may use contractors to carry out some of the maintenance or improvement operations, and may repair some of its plant in outside garages; these garages should also be regarded as contractors.

The contractors carry out the work and charge the Highways Department with the cost of the finished work according to the approved tender. The cost of these operations may consist of the cost of supplying materials, delivery of materials and/or cost of labour and plant where and when appropriate.

The classification of main code 5 Contractors Work, has been divided into three sub codes each representing a general type of operation. first sub code is for maintenance work, the second is for improvement work, and the third is for plant repairs. The first and second sub-codes have been divided into main and sub groups in the same manner as the cost units code; this is to facilitate comparisons between the cost of operations carried out by contractors and by direct labour. This procedure implies a four digit code, and in order to keep the significance of digit position, it is suggested that a "zero" should be added to represent the cost of the contractor works as a cost element. It is possible to break down the operation into a number of small operations and, in this case, a serial number should replace the "zero" in the code. The third sub-code, plant repairs, has been divided into a number of main groups each representing a major type of repair; each of the latter has then been divided into main groups, sub groups and cost elements in the same manner as the plant cost centres codes. The framework of this main code is as follows:

Main Code No.	Sub Code No.	Main Group Code No.	Sub- group Code No.	Cost Element Code No.	Description
5	51	511	5111 5112 :	51110 51120	Contractors Work Maintenance operations Structure maintenance Surface dressing Patching
			: 5118	51180	Gully emptying and maintenance of drainage system
		512	5121	51210	Aid to movement snow and ice clearance
			: 5127	51270	Maintenance of road lighting
		513	5131	51310	Amenity function operations grass, tree, and hedge cutting sweeping and cleansing
	52		3132	01010	Improvement operations
		521 522			Structural operations
	53	523	5311	53111	Aid to movement operations plant repairs Maintenance Vehicles Vans
		532 533 534 535		53112	Lorries Engine repairs Electrical repairs Body repairs Tyre repairs

Main Code 6 Fixed elements

This main code represents the cost elements which have no relation to the volume of maintenance and improvement work, the number of items of plant in the plant cost centres, or the load of work in the service cost centres.

The fixed elements have been divided into three major categories, and each of these categories has been divided into main groups, sub-groups and cost elements in the following manner.

The main code 6 fixed elements has been divided into three sub-codes, administrative materials and utilities, employees cost and expenses. The following is a brief summary of each one of these sub codes.

1. Sub-code 61, Administrative materials and utilities

This sub-code should cover all administrative materials, and utilities which are needed for lighting, heating etc.

2. Sub-code 62. Employees costs

This sub-code represents the fixed cost elements which should not be included in the calculation of maintenance and improvement operations, it also covers the cost of the different categories of workers classified under main code 2, labour, during training, holidays and /or sickness.

3. Sub-code 63. Expenses

Sub code 63 expenses, represents the general administrative cost elements which are classified into main groups each representing a type of expense in the following manner.

3.1 Main group 631. Cost of communication;

The cost of different means of communication in the different locations of the Highways Department. The cost of each of these means has been divided into different items of costs each representing a type of expenses.

3.2 Main group 632/33. General expenses;

All types of administrative expenses.

3.3 Main group 634. Office equipments and furnishings;

The maintenance and repair costs, and depreciation of these items as a separate cost element.

3.4 Main group 635. Mobile plant expenses;

The annual road licence and insurance, and any other annual plant expenses - allocation of plant expenses will be described in part three.

3.5 Main group 636. Building occupation costs;

The depreciation of buildings, maintenance and repairs, and general building expenses.

3.6 Main group 637. Depreciation of Establishment plant;

The annual depreciation of establishment plant in the central repair depot and central laboratory.

3.7 Main group 638/9. Depreciation of mobile plant;

The annual depreciation of the County Council, plant. This main group code should be classified and coded in the same manner as the plant cost centres; the allocation of plant depreciation will be described in detail in Chapter 8.

The same procedures of coding which are described before have been used for coding this main code, details of this code are in Appendix 3.

Summary of the Coding System

The group codes method of coding has been used as the basis for the cost units and cost centres codes described in section two, and the cost elements codes described in section three. The relationship between these two codes is as shown in Figure 3.1.

Cost Elements Cost UNITS & COST CENTRES	Main Code 1 Mat- erial	Main Code 2 Lab- our	Main Code 3 Plant	Main Code 4 Expen- ses	Main Code 5 Con- tractor Work	Main Code 6 Administration Costs
Maintenance operations	Х	X	X	Х	Х	
Improvement operations	X	X	X	Х	Х	
Plant cost centres	X	X			Х	Х
Administration cost centres						Х
Service cost centres	X	X				X

N.B. The administration costs in the plant cost centres and service cost centres, represent the allocated fixed expenses (plant depreciation and mobile plant expenses) to the appropriate plant cost centres.

FIG. 3.1. The relationship between the cost units and cost centres codes and the cost element code.

The suggested coding system is very flexible, it permits expansion of the code through the sub-codes, main groups, etc., which were left blank throughout the codes. It is also possible to add another digit to the code if there is a need for more information, and it is up to each Highways Department to determine the scope and size of information which is required for the different levels of management; accordingly the cost units and cost centres codes and the cost elements codes may be prepared.

CHAPTER 4

THE COST ACCOUNTING RECORDS FOR THE HIGHWAYS DEPARTMENT

The cost accounting records for the Highways Department consist of the cost units records and the cost centres records. These records should use the cost units and cost centres codes, and the cost elements codes described in Chapter 3, and they will be described in this chapter in the following manner:

Section One: The service cost centres records.

Section Two: The plant cost centre records.

Section Three: The administration cost centres records.

Section Four: The cost unit records.

SECTION ONE

The service cost centres records

The Highways Department services cost centres are located in the central repair depot, divisions, and central laboratory. These cost centres provide services demanded of them internally up to the limit of their capacity. Their costs should be allocated to the cost units and cost centres using their services. SHILLINGLAW presents two basic principles which should be used in determining the transfer price of the service cost centre services, these principles are: (1)

- 1. The profit centre should not be charged at all unless some functional relationship can be determined between service centre costs and the profit centre's demand for the service.
- 2. Above all, no after-the-fact distribution of actual service centre costs should be made. Actual unit costs for services are related to the total volume of service provided and to the efficiency with which the service centre is run.

In the Highways Department there are no profit centres, instead there are service cost centres in the central and divisional laboratories and the plant cost centres which may need the services of the central repair depot service cost centre and the divisional workshops. The same principles as presented by SHILLINGLAW, should be employed in determining the transfer price of the service cost centres costs to the cost units and plant cost centres.

A cost accounting record should be kept for each of these service cost centres and the appropriate cost accounting offices should be responsible for recording and filing the prime document used in these service cost centres in the following manner.

G SHILLINGLAW. "Guides to Internal Profit Measurement" Harvard Business Review. Vol. 35 No. 2 March-April 1957. p. 92.

The central repair depot cost accounting office

This office should be responsible for keeping the cost accounting records required for calculating the cost of the central repair depot service cost centres and, at the same time, the divisional workshops as classified in the service cost centres code described in Chapter three.

A separate record should be kept for each service cost centre and should contain information about the costs of the service cost centre which will enable the plant engineer to control cost and measure the service cost centre performance. The suggested recording procedures necessitate that all materials issued from stores or purchased from an outside supplier, the fitters cost, and all other expenses, should be allocated to the appropriate service cost centre and recorded in its record before charging the cost to the different plant cost centres using the services. The suggested service cost centre record - Figure 4.1 - consists of two main parts as follows:

- The first part is for recording the actual costs of the service cost centre which consist of the cost of materials, fitters, and expenses.
 - 1.1 Materials. All materials which may be used in the central repair services cost centres are classified under the cost elements main groups 152 gas, 153 grease, and 156 spare parts; the record contains information about quantities, price per unit, and the cost of each of the materials classified under these main groups according to the cost element code main group 156 is not divided to its cost elements as it will be allocated and recorded in detail in the appropriate plant cost centre record. The number and date of the stores issue note should be recorded against each entry in the record.
 - 1.2 Fitters cost. This cost should be recorded according to the cost element sub code No. 26 fitters. The number of hours, rate per hour, and/or cost should be recorded for each cost element. The payment slip should be used as the prime document for any entry in this record, the date of payment, and the fitter's name and number should be recorded against each entry in the record.
 - 1.3 <u>Expenses</u>. Expenses cover the allocated establishment plant and equipment depreciation (methods of allocation will be described

RECORD
COST
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REPAIR
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				Camptity		HAH	
		156	,	Price per unit		PARTS FOR FLAIT	
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				Quantity	Ę,		
			15330	Price per unit	"heel hub-		
				Cost		_	
				Quantity	anism		
			15320	Price per unit	Brake nechanism	GREASE	
		153		Cost	Brak	년 -	
				Quantity	9 9		
			15310	Price per unit	Soft Grease		
				Cost	S S		
			5	10 4 813	Total		IALS
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u			15230	Price per unit	Acety] ene		
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Resale price		152	<u> </u>	Cost		-	
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Total cost			15210	Frice per unit	Propane		
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C = Cost, R = Rate per hour, H = No. of hours

(1) To be coded according to the appropriate cost element code.

Arnual int.			43900	Ç.	of hours		r Overhead Rate	
Annual depreciation c			156 22	Cost			for Eitter t cost	ALLOCATED COST
Resale		RICCVERIES		Total			Parts for plent	ALIOC
Total cost		FUTC		Order Cost T	• • •			
Date acquired			,	No. Date Or				
Document description	·	(1)		cu			Establishment y plant allocated depreciation	EYPENSES
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No.			263	263 263 263	20 10	Superannuation G.N.I.P. National Health I.	 Total employment cost	
			26200		of hour	3	Bonus payment	
		96		26120	C FE		Overtine	HITTERS
	JUE NO.		261	T 26110	и		Total Basic	
	SERVICE CENTRE CODE No.			Totals	ಎ			
	SERV							

Fig 4.1. cont.

later), and the cost of electricity used in the service cost centre; preferably there should be a meter for each service cost centre to measure the number of kilowatt-hours used; information about the number of kilowatt-hours rate per unit, and its cost should be recorded.

- 2. The second part of the record is for recording the cost recovery; it represents the cost of repairs and maintenance work charged to the plant cost centres. Therefore this part of the record should cover the following information:
 - 2.1 Information about the date of completing the work, job order number, and plant cost centre number to which the cost should be charged.
 - 2.2 The total costs of spare parts replaced for the item of plant and which should be allocated to the plant cost centre.
 - 2.3 Information about the number of working hours spent in repairing or maintaining the item of plant and its cost.
 - 2.4 The cost of overhead charges, representing those costs which cannot be allocated directly to a specific job order.

This information should be obtained from the repairs or maintenance work "Job Order" which should be the prime document for any entry in this part of the record. The "Job Order" - Figure 4.2 - consists of five sections which should be completed by the depot superintendent, the service cost centre chargehand, the service cost centre fitter, and the depot cost accounting office in the following manner:

1. The depot superintendent should complete section one, covering information about the service cost centre, which should carry out the work, code number, the code number of the plant cost centre to which the item of plant belongs, the description and registration number of the item of plant, and the description of the work required. He should also complete part 'A' of section two and three, which in section two represents the parts which required replacement, and in section three represents the estimated fitters number of hours required to carry out the work according to the job specifications which should be introduced by the work study section.

JI. LABOUR A. Estimated hours	1.1	Bate Noting Not		(2) [C] 44 0 6-	Cost element Rescription No. of Rate of code No.	26200 Donus payment 263 Emmlerment cost	Crargehand signature	IV, CVENELES	Total Total Total Total About hours hour Cotal overtime hours hour	V. COST SECTION	Cost Code No Lescription This week total Last week total to aste	156 Total cost of parts 26 Total cost of labour 43900 Cocrheads	RECORDED Di: 1. Plant cost centre record no by 2. Service cost centre record no by
JOB ORDER NO.	Date. Registration No.	Superintendent signature	Pakts for Plant	Quantity Description				OC THE	Description Quantity per Cost				
I, JOB	Service cost centre No. Flant cost centre No. Flant description Job instruction		II. PAN	emantity Description			טירם שליים!	+1000	Rate Issue Element Note No.				

- 2. The fitters should enter their actual working hours in part 'B' of section three after completing the work.
- 3. The chargehand should enter the actual materials replaced according to the stores issue note in part 'B' of section two and approve the fitters working hours, and send the 'Job Order' to the depot cost accounting office.
- 4. The depot cost accounting office should price the parts recorded in part 'B' of section two according to the priced copy of the stores issue notes received from the purchasing office, and enter the cost element code number according to the cost elements codes. The office should also complete part 'B' of section three which deals with calculating the fitters costs according to their wages and according to the total number of fitters hours had a predetermined rate per hour for allocating the service cost centre overhead, the office should complete part four, and should then record the total cost of section two, three and four in section five.

In the divisional workshop part 'A' of section two and three should not be used, as the divisional fitter deals with the whole work. The divisional manager should approve the division job orders before sending them to the depot cost accounting office.

The 'Job Order' should be completed immediately after completing the work, or, at the end of the week, if the work required a long period to be completed.

The service cost centre record should facilitate cost control, as the entries in the first part of, the record are through a different prime document.

The stores issue notes and the fitters' payment slips, are the prime documents for any entries in the first part of record, and section five of the job order is the prime document for any entries in the second part of the service cost centres records.

The parts costs, and the fitters' costs recorded, in the two parts of the record, should be the same all the time, and any variances should represent parts issued from the stores and not fitted in plant, and/or fitters idle times. If these are the same, and there is a favourable or unfavourable balance in the record, it should represent an under - or over-recovery of overheads which will necessitate the recalculation of the charged rate per hour. (3)

The central laboratory cost accounting office

This office should be responsible for keeping records for the service cost centres within the central laboratory and the divisional laboratories. The service cost centres record and the 'Job Order' should be used with changes in the cost elements and the service cost centres code numbers, and the number of cost unit code number replacing the plant cost centre code. (4)

The basic idea of calculating and recovering the cost of the service and centre is employed. The procedures for preparing the 'Job Order' should also be the same as described before, taking into account the fact that all these procedures should take place in the central laboratory (if it is a separate section of the Highways Department as suggested in Chapter One). The relationship, between the divisional laboratories and the cost accounting office should, also be the same as described before. If there are only small divisional laboratories, without a central laboratory, the cost accounting section in the head office should be responsible for keeping their service cost centres records.

The use of the established plant number of hours, as the basis for calculating the allocated overhead, has been examined and overruled as it does not represent an accurate measure of time spent in the work required for each item of plant in the service cost centre.

The laboratory service cost centre presents its services to the different maintenance and improvement operations. The laboratory may carry out different types of analysis, before the start of the work, in order to determine the different types of materials and plant to be used in the work. The cost of these services should be allocated to the appropriate cost unit as described in Chapter 2.

SECTION TWO

The plant cost centres records

The plant costs should be accumulated by cost centres; each cost centre may cover a number of similar types of vehicles or plant or may cover only one item, depending on the existing number of plant owned by the County Council. It is important to calculate the cost of each of these cost centres as accurately as possible in order to be able to determine the rate per day or per hour of each centre. This should then be allocated to the cost unit as the cost of plant used in carrying out the maintenance or improvement work, and also to aid the control of the cost of maintaining and repairing the County Council plant. This should be achieved through the plant cost centre records, Figure 4.3; separate record should be kept for each cost centre in the central repair depot cost accounting office.

The plant cost centre record should contain information about the plant cost centre code number, and the items of plant included in it, this information being recorded on the top of the record. The operating costs of the plant cost centre should be divided into cost elements, each representing a type of cost, according to the cost element codes, used as a heading in the record. The record is divided into six sections, each representing a type of cost in the following manner.

- 1. Section one, covers the cost of materials which are needed for running plant and which are classified under main group 151 liquid materials, which includes the quantities, price per unit, and cost of each of these type of materials. These details should be recorded immediately after issuing materials from stores or buying them from outside suppliers. The stores issue note and/or evidence of purchase should be the prime document for entries.
- 2. Section two, covers the cost of repairing and maintaining plant in the central repair depot. It consists of the cost of spare

			(irice per unit		-	
			15610	Cost		Spare	
			Total		Materials total cost		
		L_	Total		Totals	-	
				quantity		-	***********
			1.32	Price per unit		Diesel	
			131	Cost		976	
			24	Quantity Price per		Rear axle	
			15124	unit		Rear	
	•			Cost			
	cost centre code no.		23	Quantity Price per		Brake fluid	
	TRE O		15123			混石	
	ST CEN			Cost			Tr
	Ö	151	22	Quantity Price per		pox 7	liquid materials
			15122	unit		Gear box	TOID !:
ន				Cost			EL
Armual depreciatm.				Quantity		Lubricating oil	
deps			15121	Price per unit		ubrica OL	
Resale				Cost			
M E			2	Quantity		ල පු සු	
cost			1512	Price per unit		Distilled water	
Total less t				Cost		A	
Estimated Potal cost use/year less tyres			Total	l quantity		Total	
Estin use/			Tota	l cost		음음	
life				s c			
Estimated economic life				Totals			
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Date acquired			ø				
H &			on Not	t No.			
tion			isiti	cr Receipt No. or Job Order No.			
Description			Regi	· ''' - '''			
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4.3.	
Fig. 4.3	

		Total		
Recoveries		lute per		- g.
Recoy		No of days		ALLOCATED
	636	62		
	63520 63		Depreciation	SES
63	10 633	(")	Insurance	OCASED ENCEN
	ब्य ८३५१०	(")	Road licence	ALLOCAFED FIXED EXTERSES
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	535	CP3	Tyre repairs	. SYI
	25	C ⁴ 3	Body repairs	MAINTENATOB AND REPAIRS BY CONTRACIORS
EZ	533	Gel	Electrical repairs	CE ANI
	532	Ca)	Engine repairs	TENAL!
	531	બ	Maintenance work	KIAIN
	Potal	બ	Total cost	
•	4350	ń	Strengthening of crossing	
	43400	G.	Erection of plant	
m	43300	വ	Moving of plant	SESY
43	35.00	(₄)	Gas cylindor rental	EDCPENSES
•	3100 4	(n)	Garaging	
	Totag 3100	ડા	Total	
T	2	બ	Service cost co overheads	entres
		No. of	Ç.	-
	26	Cost	Fitters	
-		Quantity	9.1	-
	15640	Price per	Body repairs	**
	15	Cost		ENCE E
		Quantity		
757	15630	Price per unit	Batteries	I REPAIRS AND HALHTHANDE BY COUNCIL PACILITIES
156/22/44	156	Cost	Bat	MIRS
-	-	, , , , , ,		6명 - 15명
	15620	Quantity Price per unit	7,776	I PARTS FOR PLANT THE COUNT
***************************************	15	Cost	<u> </u>	eris ec
	-			_ -
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parts, which should be recorded in detail, fitters costs, and overhead cost. The 'Job Order', described in section one of this chapter, should be the prime document for entries.

- 3. Section three, covers the running expenses which may accrue during the year and which are classified under sub code 43. expenses; the evidence of purchase should be the prime document for entries.
- 4. Section four, covers the cost of maintaining and repairing plant by outside garages which are classified under sub code 53, plant repairs. The prime document should be the garage invoice or evidence of purchase.
- 5. Section five covers the allocated fixed costs which consist of road licences, insurance, and depreciation. The method of allocation will be described in detail in section three.
- 6. Section six is for recording the allocated costs to the different cost units according to the predetermined rate and the actual number of working days. The prime document should be the haulage note or the plant form.

The plant cost centre record should help in controlling the cost of repairs and in revising the predetermined rate of allocation. It should facilitate the comparisons between the actual cost of the plant cost and the allocated cost which may be used as a measure for evaluating plant utilisation.

SECTION THREE

The administration cost centres records

The administration offices, which are in the different location of the Highways Department, have been classified and coded under cost centres main code number 4. The administration costs have been classified under the cost element code number 6. According to the marginal costing theory, which is the basis of the cost accounting system, the administration costs (fixed costs) should be calculated separately and this requires that the following cost record should be kept for each of these administration cost centres in the appropriate cost accounting offices or sections.

1. The administrative materials and utilities record

In this record, the cost of printing papers, stationery, etc, and the cost of utilities, classified under the cost element sub code number 61, should be recorded. The entries in this record should be the materials invoices or evidence of purchase. Figure 4.4 represents the suggested record.

2. The employees cost records

Different categories of employees are usually working in the different locations of the Highways Department; these categories are: (a) technical staff, (b) clerical staff, (c) inspectors or superintendents - except in the head office. The cost of each of these categories is classified in the cost element code, under a separate main group, and therefore their costs should be recorded separately in a separate record.

The employees' cost record should be prepared for each category of employee. The record represents the details of the employee cost as classified and coded in the cost element code. The entries in this record should be made at the time of payment (on a monthly or weekly basis), and the employees' salary slip should be the prime document for entries in this record. Figure 4.5 represents the employees record for the technical

ADMINISTRATION COST CANTRE No.

	•	
	61540	Coal
5	61530	Gas
615	61520	Electric
	61510	Water
	Total	Total utilit.
	61400	Protect. clothing
	61300	Maps & plans
	61200	Text books
	61100	Printing & Stat.
	61	Total cost
	Description	
	Date	
	Š Š	

Fig. 4.4 The administrative materials and utilities record

	62147	Training courses and exumination fees
	62146	Redundancy payment
	62145	Financial aid
6214	62144	Ex gratia payment employees
O	62143	Gratuities for dependants
	62142	Compensation for loss of office
	62141	Travelling and subsistence
	Total	Total expenses
	62133	Superannuation
	62132	Graduated National Insurance Pension
6213	62131	National Health Insurance
	Total	Total employment cost
	62120	Overtime
	62110	Salaries
	621	Total Technical Staff cost
	Name	
	44	
	Staff No.	
	Late	
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ARABISTRAPION COST CENTRE No.

staff. Therefore, the classification of cost elements, under main group 621, technical staff, is used as a heading for the record. A similar record, with a different cost element main group code should be used for clerical staff and inspectors and superintendents.

3. Cost of communications cost record

In this record, the cost of communications between different locations of the Highways Department, and other communication costs paid by the department, should be recorded. These types of costs are classified under the cost element main group 631; therefore each cost element classified under this main group should be used as a heading in this record. Figure 4.6 represents such a record. The entries in this record should be through the invoices or the evidence of purchase.

4. General expenses cost record

All types of general expenses which, are classified under main groups 632/634, should be included as headings in this record. The entries should be made through invoices and receipts of payment. Figure 4.7 represents this record with the different cost elements classified in the suggested cost element codes - Appendix three - as headings.

5. Office equipment, furniture and building costs cost record

The cost of office equipment, furniture and buildings should be calculated through this record. The cost of office equipment should cover the running cost of all office equipment items such as typewriters, calculating machines etc. which may be kept in the administration cost centre. It also covers their annual depreciation.

The running costs such as the repairs and maintenance costs and depreciation of the cost centre furniture, are also included in this record under appropriate headings. The record should also cover the administration cost centre building costs, including depreciation of the County Council owned buildings and all other costs need to maintain the buildings in good condition. These costs are classified under the cost elements main groups 634, office equipment and furniture, and 636, buildings' occupation costs. The cost elements classified under these main groups

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communications rec
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Cost
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	:3153	Running cost	
6315		Maintenance cost	g
(3)	33.51	Depreciation of equipment	PADAR
	Total		
	63143	Running cost	
6314	63142	Maintenance cost	日日
63	63141	Depreciation of equipment	
	Cotal		
	63133	Running cost	
6313	63132	Maintenance cost	RADIO
ó	63131	Depreciation of equipment	T.F.
	63125 Total		
	63125	Clerical staff residences	
	63124	Inspectors residences	
6312	63123	Rondmen, fitters & drivers residences	TELEPHONES
63	63122	Technical staff residences	TELE
	63121	Offices	
	Potal		
	63114	Ciro charges	
	63113	Franking machine	ST
6311	63112	Rogistored envelopes	POSTAGE COST
	63111	Stamps	Post
	Total		
5		TOTAL COST OF COLLUNICATION	
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7 + 4 5 m 0 m 0 m	nescription		
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AMILICISTRATION COST CENTRE No.

Bank charges
Адепсу Геея
Consultancy fees
Logal fees
Fees
Advertisements
Laundry
Computer charges
Newspapers .
Societies
Subscriptions
Medical examination
Entertainment of County guests
Travelling expenses
Fees
Conference expenses
General expenses

ADMINISTRATION COST CENTRE No.

are used as headings in this record - Figure 4.8. The entries in this record should be the invoices or receipts for payment for the running cost and an annual entry for depreciation calculated according to the appropriate rate and method of calculating the annual depreciation.

The above five records should be kept in each of the Highways Department cost centres and used to present the total cost of the cost centres. In addition to these records, the central repair depot, the central laboratory and division adminstration costs centres, should keep records to calculate the unallocated cost of labour and the first two cost centres should also keep a record for mobile and establishment plant depreciation. These types of costs are classified under the appropriate cost elements main group, which are classified under main code 6, fixed costs.

Labour fixed costs records

According to the marginal costing theory, the variable costs should only be allocated to the cost unit, and it is necessary to classify the cost elements into variable and fixed cost according to their relation—ship to the cost unit. The costs which have a direct relationship with the cost unit are regarded as variable costs, and those which have not this direct relation are classified as fixed costs, therefore the cost of the different categories of labour which can not be traced directly to a cost unit such as their cost during holidays, sickness etc are treated as fixed costs and should be calculated in this record.

The record should be kept for each category of labour as classified in the cost element codes in the appropriate administration cost centre. The records should be identical except in the cost elements codes number which should be related to the category of labour which the record represents. The record should consist of four sections, each representing one of the sub-groups - wages, bonus, employment cost and other expenses, and each of these sections should then be divided into a number of columns each representing one of the sub-groups cost elements. Figure 4.3 represents this record for road men, the entries in these records should be on a weekly basis through the workers pay slip.

8.4
Fix.

			53533	Innurunce	<u></u>	
			3636	Cleaning buildingo		ω l
		.,	3.31	Rent		SUSCESSUS
636		٠	Totel	Genoral expenses		OCCUPATION
		63620		Maintenance and repairs		BUILDEIG (
		63610		Depreciation		BO
	I	Total		Total		
			634,92	Maintenance and repairs		
		6349	63491	Depreciation		
		Potal		Total		
			63432	Maintenance and repairs	Photocopying m/cs	
		6343	63431	Depreciation	tocopy	
			Total	Total		TORE
	₩9 		63422	Enintenance and repairs	Calculating machines	equiplent and furlifure
		6342	63421	Depreciation	ulating	FLEAT A
			Total	Total	Calc	
			63412	Maintenance and repairs	ers	OFFICE
		6341	63411	Depreciation	Typewriters	
			Total	'Potal	Ç1	
			Potal			
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	J#ren	Training courses and examination fees	d .
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	.2445	Financial aid	
,	52474	Ex exatia payment employees	
(24,4	62443	Cretuities for dependents	
	62442	Compensation for loss of office	
	62441	Travelling expenses	
	Total	Total of other expenses	
	62433	Superennua tion	
	62432	Graduated Mational Insurance	
6243	62431	National Health Ins	•
	Total [Total employment cost	
-	52423	During sickness	
	62422 5	During holidays	
6242	62421 6	During training	
	Total	Total bonus	
	62413	During sickness	
	62412	During holidays	
6241	62411	During training	
	Total	Total wages	
	624		
	пете		
	Worker name		
	Corker No.		
-	Late		
L			

ACCIDINATION COSP CENTRE NO.

The establishment and mobile plant records

Plant annual depreciation should be included into the plant cost centre record as a part of the plant cost which should be the basis for calculating the rate of charging plant to the cost unit. The plant cost centres should only be charged with depreciation for the working days; they should not be charged with depreciation during plant idle time and major repairs in the central repair depot or at outside garages.

The plant depreciation should be allocated to the plant cost centres according to the actual working days on the basis of a predetermined rate per day. This rate per day should be calculated according to the plant cost centre total depreciation (number of item of plant x annual depreciation (5) and the estimated annual working days which should determine the estimated working days every three months. The estimated allocated depreciation should then be calculated for every quarter (estimated working days during each quarter x rate of allocation per day). The total estimated allocated cost should be the same as the total annual depreciation as depreciation should be absorbed completely if the programme of work is completed. The actual working days for each item of plant during every quarter should be calculated and multiplied by the estimated rate per day to determine the cost of depreciation which should be allocated to the appropriate plant cost centre. The difference between the estimated and actual allocated depreciation represents the cost of idle capacity.

The plant depreciation record - Figure 4.10 - represents this type of record, which should be used for mobile and establishment plant. The record covers all the information needed to calculate the allocated depreciation and idle capacity costs as described above.

The total administration costs should be calculated by recording the totals of the previously mentioned records monthly in a general administration cost record as in Figure 4.11.

⁵ Annual depreciation method will be described in Chapter 8.

⁶ The plant programme of work will be described in Chapter 8.

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	bulance till the end of period	
ter	Allocated costs 👸	
Fourth querter	Actual working days	
Four	Estimated cost	
	Estimated working days	
	Balance till the end of period	
ter	Allocated cost	
Third quarter	Actual working days	
Thi	Estimated cost	
	Estimated working days	
	Balance till the end of period	
er	Allocated costs	
Second quarter	Actual working days	
Second	Estimated cost	
	Estimated working days	
	Balance till the end of period	·
31.	Allocated costs 9	
quarter	Actual working days	
First	Estimated cost	
	Estimated working days	
Rat	e per day	
	imated annual king days	
Tot	al annual reciation	
Ann	ual depreciation	
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	Control No.	

ſ		П	
	,	638	Mobile plant Idle capacity cost
DESCRIPTION:		637	Establishment plant idle capacity cost
	634 635		Office equipment furniture and buildings cost
	,	6 32 633	General expenses
		631	Cost of communication
		627	Techni cians
		626	Fitters
	-	625	Drivers and plant operators
	62	624	Roadmen
	٠	623	Superintendent or Supervisors
	•	622	Clerical staff
	-	621	Technical staff
			Total employers cost
CENTRE CODE NO.:		61	Administration materials and utilities
		Month	
COST CE	N.		

The administration cost centre code number should be recorded on the top of each record according to the administration cost centres code described in Chapter three.

SECTION FOUR

The cost unit records

The cost unit records represent the cost accounting records which should be kept for recording the cost of the maintenance and improvement operations which may consist of materials, labour, plant, expenses, and contractor work costs, or may consist of some of these costs according to the type and/or the volume of the operation. In all cases the appropriate cost records should be kept for recording the cost of each cost element.

1. Materials Records

The materials records should represent the actual cost of the materials used in the operation in order to compare them with the predetermined cost and to prepare material variances reports for the different levels of management in the Highways Department.

A variety of materials records which suit different circumstances may be used for recording materials costs used in maintenance and improvement operations, and in general each of these records should be divided into two parts. The first part is for recording materials costs, and this should include information about the quantities of materials used, the price per unit, and the cost of these quantities. The second part is for recording the haulage costs which should consist of:

(1) the cost of haulage when using the county council lorries; this should indicate information about the number of miles between the division depot, or the suppliers stores, and the sites, the rate per mile as estimated by the central repair depot, and the cost of haulage and quantities transported. (2) The cost of haulage when the supplier delivers the materials directly to site by his own lorries; this should include information about the quantity of materials delivered to site, the price per unit of materials, and the cost of haulage.

The total cost of materials should consist of the total of the first part, materials costs, and the second part, haulage costs. Entries in this record should either be from the store requisition or the receipt of materials signed by the foremen on site for materials delivered directly to site, and the haulage form for the county council lorries.

The size and number of materials records which should be kept for each operation should depend on the types and number of materials required to complete the operation.

The following is a brief description of some of the materials records which should be kept for recording materials costs in particular circumstances.

- 1. In case of an operation requiring more than three items of materials classified under the same sub-group in the cost element codes, a separate material record should be prepared for recording the costs of these items of materials. Figure 4.12 represents such a type of record and, as an example, the figure represents the materials record for materials sub-groups 1111 'slag' and 1911 'haulage of slag'.
- 2. Figure 4.13 represents the materials record which should be kept for an operation which does not require more than two items of materials classified under the same sub-code. It has been assumed that the operation requires two items of materials classified under sub-groups, 1541 'timber', and 1954 'haulage of timber', and only one item of materials classified under sub-groups 1511 'liquid materials', and 1951 'haulage of liquid materials'. This type of material record may extend to include up to four sub-groups each covering up to two items of materials.

RECORD No.
t
RECOMDS
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CONSTRUCTION

			quantities transported		ies	
		12112	irice per unit		Hired lorries	
			Coat		Hired	
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SIMG	Slag		Quantity			THE MADERIALS DAIN PART
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			Quantity			Ţ
		11111	Price per		152 - 22&nm Slag lump	
			unit Price		152 - Slag	
	l	Tota	l quantities			
	•	Tota	l price		Total	
			7-	4 to	Cost of Slag	of age
		7	1911	Potal cost	Cost	Cost of Haulage
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AD CO		tion]	No. Form			
)H		Requisition Note	Receipt No. Kaulage Form No.			
			Date H	,		
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Sub-group record for miscellaneous material. Fig. 4.13

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- 3. A main group record may be used to show the total cost of materials if the materials required for the operation were recorded in a number of sub-group records. The total of these sub-group records should be carried forward from the sub-group records and recorded in the main group record; each period may vary between a week and a month according to the need and importance of the information obtained from the record. Figure 4.14 represents this type of record illustrating the main group 141 'fences', and 1941 'haulage of fences', record. Entries in this record should be through the sub-group records and this means that there is no relationship between the prime documents and the record.
- 4. Another type of main group record which may be prepared for each, large project, division, or whole department, is the haulage record, Figure 4.15. This record, as for any main group, depends upon the sub-group records and, therefore, also has no relationship with the prime documents. This type of record should be prepared if the information included in the record is needed. Figure 4.15 illustrates the haulage record for construction materials which may be used for a large project or for each division. Another column for recording the division number should be added to the record if used for the whole department.

The calculation of the total materials cost used in the operation should be recorded in one of the first two records described above and this necessitates the separation between the purchase price and haulage cost of the different types of materials; this should then appear in the prime documents and in all materials tenders.

2. Labour Records

The purpose of the labour records is to calculate the labour costs, and to facilitate the presentation of information needed for control and decision making. This information should cover analysis of the weekly hours and their corresponding costs.

The main group record for recording the totals of sub-group records

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C	Ha co	antity ulage st terial nice																		G00%	Totals of sub-group as	
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7.425	Kar pr:	terial ice																		SUSCEPTE POSTS		

ROAD COLE NO.

wantity

COST UNIT CODE No.

AID TO MOVEMENT MAPHRIALS RECORD NO.

Fig. 4.14

Fig. 4.15

	,	 ,					
		19172	quantity		Hired lorries	*	
	7	5,	Cost				
	1917	19171	Quantity		C.Council lorries	SEMEN	
•		31	Cost		0.0 Hot	HAULAGE OF KERBS	
DIVISICH HO.		Tot	al quantities		m	HATTLAC	
SIAIG		Tot	al cost		Totals		
		19152	Quantity	,	hired lorries	IAIS	83
	5	-	Cost			HAULAGE OF LIQUID LAPERIALS	ROOGH.
	1915	19151	Quantity		lorries	מנטאו	SE.
O			Cost		2 19	T 40 !	D FRO
PROJECT No.			al quantities		Totals	AULAGE	FORWAR
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		19142	Quantity Cost		lorries	WEELA	SS CAR
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	1914	19141	Quantity		lorries	H-SE	an cuk
	ı	Tot	al quantities			E 0F 1	OST A
•			al cost		200	HAULAGE OF PRE-MINED MARGELAL	CAGE C
		01	Quantity				P HAU
		19112	Cost	12	lorries	IAIS	TOTAL OF HAULAGE COST AND QUANTITIES CARRIED FORWARD FROM SUB-RECORDS
	1911	_	Quantity			HAULAGE OF DRY MATERIALS	Œ
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HAULAGE RECORD No.

The cost unit labour cost consists of the actual costs of the permanent and temporary roadmen, and/or the lorry drivers and plant operators (6) who are directly involved in carrying out the work in the operation for the whole day or part of the day, this being normal procedure in the Highways Department. There should be a separate record for recording the cost of each category of worker, which is not different except for the use of the appropriate code number in each record as classified and coded in cost element code No. 2 - Appendix 3.

Figure 4.16, represents the labour record for permanent labour, the record covers the workers personal information such as his name, number, rate per/hour, and gang number; it also covers the different sources of payment as classified in the labour code, consisting of wages, bonus payment, and employment costs. The items of labour cost which represent the detail of each of the above main groups are used as the headings of two columns, the first is for the number of hours spent on this item, and the second is for the cost of these hours according to the worker rate per hour. (7) Entries in the labour records should be from the workers' weekly worksheets.

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The lorry drivers and the plant operators costs were not included in the plant daily rates for the following reasons.

⁽a) It facilitiates the calculation of the plant rate per day or per hour for each of the plant cost centres.

⁽b) The lorry drivers or plant operators may be involved in the improvement or maintenance manual work.

⁽c) The Highways Department may hire an item of plant without the operator.

⁽d) The Highways Department may use a temporary driver or plant operator for its own plant.

⁽e) The separation between the cost of hiring items of plant and the cost of drivers or operators should facilitate the presentation of information used for comparisons and decision making.

⁽f) The drivers and plant operators records should facilitate the control of the cost of these workers.

The calculation of rate per hour for the hired plant drivers and operators necessitate that the hiring companies should separate between the cost of the hiring items of plant and the cost of the drivers or operations and their tenders and invoices.

OVERTIME PAYRUM		
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ROPHIER PERSONAL INFORMATION		

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3. Plant Records

This record represents the cost of plant used in each operation according to the number of days for which each item was used, and the rate per day which the central repair depot, (8) or the plant hiring company, charges for the use of this item of plant. The plant records should facilitate the presentation of plant costs, used in the operation, in such a way as to enable management to control the cost of plant and for decision making. The plant code No. 3 - Appendix 3 - should be used as the heading of the plant cost record. The size and number of records which should be kept for each operation depend upon the number of items of plant needed for each operation and its source. Therefore, the plant records may cover the cost of a main-group, or sub-code of plant in the following manner.

This record should be used when (1)The main group record. there are a large number of items under a main group of plant in use in the operation. Figure 4.17 is an example of this type of plant record. The figure illustrates the plant record for an operation which needs: two emulsion sprayers (the central repair depot provide one and the second is hired from a hiring company); twin burner heater and planer (provided by the central repair depot); bitumen heater, asphalt power finisher, and sand spreader (hired from a hiring company). appropriate cost element code for each of these items of plant is used as a heading in the record, and each heading covers information about the actual number of working days, the rate per day and the total cost.

This rate should be predetermined for each plant cost centre, and should be recorded in the plant cost centre records as recovered costs.

The plant main group record
Fig. 4.17

		No. of days			
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	·	Cost	Ø	Syce	
		lio, of days	Y G E		
	32226	Rate per day	1.6 3.7	finishers	
		Cost	AS DD	fi	
3222		No. of days		eater	
X	32223	Nate per day		Bitumen heater	HINED PLANT
		Cost		Bit	日
		No. of days	T.	ine	
	32221	Rate per day	mulsio	sprayer petrol engine	İ
		Cost	. III	petr	
	Total	no. of days		Total	
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		No. of days	•	H	
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		Cost			
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	32214	Rate per day	mą diy	heaters	
3221		Cost	Ę	,~-	407
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	32211	Rate per day	m. I. Salon	sprayer petrol engine	COUNTY COUNCIL PLANT
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PLANT RECORDS

COST THIT COLE NO.

ROAD CODE No.

(2) The sub-code record. This record should be used in the case of an operation requiring not more than two items of plant classified under a main group; Figure 4.18 represents this type of plant record. This record, as for the previous one, should present the cost of each item of plant according to its source, and cover information about the actual number of working days, rate per day, and total cost. Figure 4.18, represents the plant record for an operation which requires the use of county council and hired vans; namely 3 ton and 5 ton county council lorries, 5 ton and 7 ton hired lorries, and a county council low loader trailer and water tank. The record represents the total cost of each item and each main group of plant, and, at the same time, the total cost of plant as classified under the appropriate sub-code.

It is possible to include items of plant which are classified under different plant sub-codes in one sub-code record if the number of plant items required for the operation is not more than six and, in this case, the record should show a separate total for each sub-code and the totals of the sub-codes. The operation, or cost unit, and the road code number should be recorded on the top of each record; the entries in the plant cost records should be from the plant weekly returns.

4. The expenses record

This record should be kept if the operation required hiring of site. The record should include the period, rate of hiring and the cost of hiring. It should also include any other operational expenses classified in the expenses code No. 4, see Appendix 3. Entries in this record should be from the hiring agreement and/or evidence of payments.

103

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			31913	facto per day		er Sk	l
			35	Cost		Water	SE
	01			No. of days		H	TITY:
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			9.	Cost		Low loader trailer	00 and
		-	র	No. of days			COULTY COURCIL FRAILESS
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5. The contractors works record

The maintenance or improvement operations may be carried out by a contractor. In this case the Highways Department will not be responsible for controlling the cost, and will not be expected to interfere with the working procedures. Its responsibility will be limited to supervising the work and paying the cost of the finished work according to the engineer's certificate. responsibility, supervision, rests with the particular foreman or engineer in the division; the second, paying the cost of the finished work, necessitates the knowledge of the payment conditions according to the tender accepted and the engineer's certification. The conditions of payment may include certain retentions from the certification total payable at the end of the operation; this is a 'cash' procedure and should not effect the cost records. Therefore, the total cost of the finished work, described in the engineer certificates, should be recorded in the contractor's record; the other financial conditions should be recorded as extra information.

Figure 4.19 represents the contractor's record for an improvement project. The cost of each operation should be recorded from the engineer's certificate under the appropriate heading. Each heading covers information about quantities of finished work, the rate per unit, as approved in the accepted tender, and the total cost. The financial information (which covers the total cost of the contract, the amount of cash paid to the contractor, and the retention from the engineer's certificates), should be recorded against any cost entries; the recording procedures of the financial information may take place after payment. The date of entries, the engineer's certificate reference and the cheque or receipt number, should be recorded against any entry in the appropriate part of the record.

6. The operational worksheets

A weekly operational cost sheet should be prepared for presenting the total cost of each operation. The totals of the cost unit records described in this section should be carried forward every week and entered in the cost sheet under the appropriate cost element code.

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	pajment	Cotal		
	Jo			
٥	Condition	Retained value		
division no.	ζ	Cash payment		
Id	-	Quentity		
	52160	Rate per unit		inous
		Cost		Bituminous surfacing
		Quantity		
	52170	Rate per unit		Sub-base Road base
	7.	Cost		Sur Road
		Quantity		્ય
	52160	Rate per unit		Earthworks
	",	Cost		Earth
		Quantity		
	52150	Rate per unit		Drainage Service ducts
•		Cost		E Sex
PRCJECT No.		Quantity		and
Рясл	52140	Rate per unit		Fencing and walls
		Cost		Fen
		Quantity		8
	52130	Rate per unit		неддев
		Cost		
		Quantity		ce
	52120	Rate per unit		Site clearance
		Cost		
		Quantity		narie
	52110	Rate per unit		Preliminaries
		Cost	·	Ā
	521	Quantity		work totals
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This cost sheet should present the weekly and accumulated cost of each operation. Figure 4.20 represents this cost sheet.

An alternative cost sheet should be kept for large improvement projects, which may consist of a number of operations. This cost sheet should, in principle, be the same as the operational cost sheet except that it should include the totals of a number of cost units records instead of only one. This project cost sheet is shown in Figure 4.21

The maintenance cost units records should be kept in the divisional cost accounting offices, and the improvement cost units record should be kept in the cost accounting section in the Head Office.

Summary of the cost accounting records in the Highways Department

A description of the cost accounting records which should be kept in the various locations of the Highways Department have been described in detail in this chapter. The relationship between the cost accounting records and the Highways Department locations can be shown diagrammatically in Figure 4.22.

The number of records which should be kept in each of the above locations should depend on the number of improvement and maintenance operations which are carried out in each division, on the size of the central repair depot and central laboratory, and on the number of plant cost centres.

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No	Date	Total	Materials Code No (1)	Labour Code No (2)	Plant Code No (3)	Expenses Code No (4)	Contractor work Code No (5)
						,	

Figure 4.20
A weekly operational cost sheet

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No	Date	Cost Unit Code No	Description of Cost Unit	Total Cost	Material Code No (1)	Labour Code No (2)	Plant Code No (3)	Expenses Code No (4)	Contractor work Code No (5)
n april a given de l'Ambair et l'en au en	en general ann clàid i righte e dòinn dà ann ait i reile in								
						and the second s			and the same of th

Figure 4.21

A weekly project cost sheet

Cost records Highways Department locations	Maintenance operations records	Improvement operations records	Service cost centres records	Plant cost centres records	Administration cost centres records
Division cost accounting offices	×				×
Central repair depot cost accounting office			×	X	×
Central laboratory cost accounting office			×		×
Head office cost accounting section		×			×

Figure 4.22 The relationship between the cost accounting records and the Highways Department locations

CHAPTER 5

THEORETICAL SURVEY OF BUDGETING AND BUDGETARY CONTROL AND THEIR APPLICATION IN THE HIGHWAYS DEPARTMENT

The word "budget" is used in cost accounting literature in two ways. It is used to describe the over-all plan of operations expressed in quantitative terms, and its second connotation refers to the sub-division of the over-all plan. (1)

Summary of the historical development of budgeting

The historical development of budgeting has been presented by SOLOMONS, (2) he mentions the use of budgeting as the source of forecasting and acting on forecasting as a very old practice; JOSEPH in Egypt, developed a budget of corn supplies, and planned PHAROH's investment and consumption policy to cover a period of seven years. In less remote times, in Britain, the practice of drawing up a Governmental budget each year is about 200 years old whereas in the United States it dates back only to the beginning of this century. SOLOMONS also mentions that the first writer to show an interest in accounting for the future as well as for the past was DE CAZAUX, whose work was on agricultural accounting. The DE CAZAUX budget was a combined business and family budget, and is almost similar to the business budgets as known today. Early in the present century the

G A WELSCH. "Budgeting profit planning and control". Second edition, (New Jersey, Prentice-Hall, inc. Englewood Cliffs. 1964) p.5

D SOLOMONS. Editor "Studies in costing". (London, Sweet & Maxwell Ltd. 1952). p.46.

incorporation of budgets into the cost records, for the purpose of controlling expenditure, was introduced by S H BUNNELL; his budgets lacked the flexibility which permits the adjustment of the budget figures according to the changes in circumstances which supervened during the period for which the budget was drawn up. At about the same time HENRY HESS expressed the basic idea of flexible budgets in his article "Manufacturing: capital, cost, profit, and dividends" when discussing the use of expense forecasts. (3)

Budget definitions

Budget has been defined by the cost accountants and other writers as follows:

In 1930 an international conference on budgetary control was held in Geneva and adopted the following definition:

"Budgeting is not merely control, it is not merely forecasting, it is an exact and rigorous analysis of the past and the probable and desired future experience, with the view to substituting considered intention for opportunities in management". (4)

A team of 34 European experts from eleven different countries, who made a survey of how accounting performed in the United States, defined budget as the following:

"A plan of operating in monetary terms, it consequently includes a forecast of income and expenditure and of receipts and costs for a specific period, usually 12 months. This notion of a plan is most important; and it is here that this form of budget differs markedly from budgets of public services, the main purpose of which is to fix the allocation of spending a department must not exceed". (5)

³ Ibid. pp.46.47

R S Edwards. "The approach to Budgetary control". Edited by S D Solomons "Studies in costing". op. cit., p. 365

⁵ R I DICKEY. op. cit., pp. 20.7-8

Before 1974, the Institute of Cost and Management Accountants presented the following definition:

"A budget can be defined as a financial or quantitative interpretation prior to a defined period of time, of a policy to be pursued for that period to attain a given objective". (6)

In 1974, the Institute published the terminology of management and financial accountancy, which contained the following definition of budget.

"Financial and/or quantitative statements, prepared and approved prior to a defined period of time, of the policy to be pursued during that period for the purpose of attaining a given objective. They may include income, expenditure and the employment of capital". (7)

SHILLINGLAW, in his book "Cost accounting Analysis and Control" defined budget as:

"A predetermined plan of action developed and distributed as a guide to current operations as a partial basis for the subsequent evaluation of performance". (8)

In the meantime, WOOD, described the budget in his article "Budgetary control: time for change?" as follows:

"Budget can be described as a set of objectives designed to satisfy an overall plan to be achieved by managers and departments in a company". (9)

DAVISON, in his article "Budgeting control and long term planning", defined budget through the following statement:

The Institute of cost and works accountants "An introduction to budgetary control, standard costing, material control and production control". Twenty-fifth edition, October 1969. p.7.

The Institute of cost and management accountants "Terminology of management & financial accountancy". op. cit., p. 45.

⁸ G SHILLINGLAW. "Cost accounting analysis and control". (Illinois, Irwin. Inc. Homewood 1967) p. 15.

W A WOOD. "Budgetary control: time for change?" The Commercial Accountant. Vol. XXI. No. 2. April 1970. p. 132

"A budget in business provides a bridge between a plan and its accomplishment. It is a financial statement which shows in detail where the business progresses toward its objectives and provides a basis for detailed instruction to employees in achieving the objective. The firm's objectives are set by the plan and a budget is useless unless it reflects a good plan. It is the plan itself which determines the profitability of the enterprise and the budget expresses this profitability". (10)

On the other hand EDEY defined the budget through a comparison between budgets and accounts as the following:

"A budget is a statement about what is expected or planned to happen, an account is a statement about what had happened. A budget therefore should be regarded as an estimate or forecast, and in this sense the account is the fundamental statement". (11)

Roy PILCHER, Professor of Buildings, University of Manchester, defined budget as follows:

"It is a device through which planning and control can be integrated".

From the above definitions, one can conclude that there is no approved definition for a budget, and it is rather difficult to define one to represent the term budget in this research.

ABDEL-RAHIM, found it easier to describe the term rather than to define it; he presents the following description:

"The budget is an approved plan of action, based on certain assumptions related to the enterprise's objectives to deal with a given future period". (13)

This description contains what this research means by the term "budget".

The budget is a plan for the next period which should be approved before

I H DAVISON, "Budgetary control and long term planning". Management Accounting, Vol. 45 No. 10. p. 406

H C EDEY. "Business budget and accounts". (London, Hutchinson & Co. Ltd. 1966). p. 9

R PILCHER. "Appraisal and control of project costs". (London, McGraw-Hill Book Company Limited. 1973). p. 204

A H ABDEL-RAHIM, "Industrial Manager's acceptance and use of budgetary control techniques an empirical approach". Unpublished Ph.d thesis, University of Manchester, Institute of Science and Technology, July 1966. p. 14

becoming a budget, and the budget should be presented to the different levels of management as a basis for the programme of work. The budget may be expressed in financial and/or quantitative terms.

Budgetary control definition

The Institute of Cost and Management Accountants defined budgetary control as:

"The establishment of departmental budgets relating the responsibilities of executives to the requirements of a policy, and the continuous comparison of actual with budgeted results, either to secure by individual action the objective of the policy or to provide a basis for its revision". (14)

DICKEY, defined it as the following:

"Budgetary control in its broadest sense means the use of a comprehensive system of budgeting to aid management in carrying out its function of planning, coordinating, and control of operations." (15)

SCOTT, in his definition of budgetary control suggested that it is a system of management control, he states:

"The term budgetary control is applied to the system of management control and accounting in which all operations are forecasted and so far as possible planned ahead, and the actual results compared with forecasted and planned ones". (16)

Other writers confused budget and budgetary control when defining budgetary control, and their definitions to budgetary control are not accurate. For example, OWLER and BROWN defined it as:

"Budgetary control is the planning in advance of the various functions of a business so that the business as a whole can be controlled". (17)

The Institute of Cost and Management Accountants "Terminology of Management & Financial Accountancy" op. cit., p. 13

¹⁵ R I DICKEY. op. cit., p. 20.13

J A SCOTT. "Budgetary control and standard costs" fifth edition (London, Sir Isaac & Sons Ltd. 1961) p.10

¹⁷ L W OWLER & J L BROWN "Cost accounting and costing methods". Twelfth edition (London, Macdonald and Evans. 1970) p. 455

and GARDEN, in his definition of budgetary control states:

"Budgetary control has been defined as an exact and rigorous analysis of the past, and the probable and desired future experience with a view to substituting considered intention for opportunism in management". (18)

on the other hand an example of an inaccurate definition, in my opinion, is the one presented by COURT, who defined budgetary control as:

"The planning and coordinating of the function in advance in order to achieve the maximum profit and efficiency compatible with the stabilising of the business, and controlling all operations so that actual results compare favourably with such budgeting plans". (19)

It is not clear, therefore, from these definitions what budgetary control is. Is it the system as a whole, or is it the procedures of planning and control in the enterprise? It is important for this research to define "Budgetary Control" as clearly as possible, and to show its relation with management. SMITH, in his article "Budgetary Control in medium size business" presents a definition which answers the above questions, and simultaneously explains what is meant by "budgetary control" he states:

"I take it to be a technique of management which plans and coordinates all functions of the business towards the objectives of maximum profitability, and exercises control to ensure that actual business operations do conform as closely as possible to the plans". (20)

According to this definition "Budgetary control" is a technique of management, and that means that it is not of itself control but a means of control provided for management, who may or may not use it for control.

Budgetary control as a technique consists of planning to achieve the objective of the enterprise which may be maximum profitability, or the lower cost of a service; this can be done through the establishment of

 $^{^{18}}$ D J GARDEN, "Flexible Budget and Control". (London, Macdonald and Evans, 1937) $\overline{\rm p.~4}$

¹⁹ H P COURT. "Budgetary control". (London, Sweet & Maxwell, 1951) p.3

JESMITH. "Budgetary control in a medium size business". The Cost Accountant. Vol. 39 No. 5 May 1969. p. 133

the enterprise "budget" and the exercising of control over all the enterprise operations through the comparisons between the actual costs and performance and those budgeted. In this research "Budgetary Control" will mean the use of budgets and the exercising of control as a technique of management which aims to help management in planning, coordinating and controlling the enterprise.

The planning function and budgetary control

Planning refers to the predetermination of a course of action in such detail that every responsible unit of the enterprise may be guided thereby. (21)

Budgetary Control requires the development of the enterprise budget which should reflect the enterprise's long-range objectives, extending beyond one year, and the short-term objectives which are generally concerned with one year. WELSCH, mentioned that management should concern itself with developing the long-range objectives which are time-segmented in detail as short-range objectives, which may be broken down further by period and department. He also emphasised the importance of bringing all levels of management into the planning function; but at the same time emphasised that:

"This should not be overemphasised as there are at least three very basic principles involved. First, active participation of all managerial levels in shaping the desired goals and the plans for achieving them has a decidedly healthful effect on interest, enthusiasm, and morale. Such personnel factors enhance esprit de corps and productivity benefits. Second, active participation by all members of management makes them aware of how their particular functional shares fit in the total operation and of the necessity for interdepartmental cooperation. Third, junior members of management, having participated in the planning function are adequately informed as to the future with respect to objectives, problems, and other considerations. Nothing is more discouraging and damaging to the morale of the lower level supervisor than to be "in the dark" about what is expected in the future". (22)

J L PRICE. "The Budget Comes of Age". Harvard Business Review. Vol. 22 No. 3 May-June 1954. p. 60.

²² G A WELSCH. op. cit., pp.9-13.

In establishing the budget, management should determine the appropriate approach which should be followed for establishing the enterprise budget according to the enterprise limiting factor. HEGAZI says that there are three approaches which can be used as the basis for establishing the enterprise budget. These approaches are: (23)

- 1. The sales budget approach, which should be used where the setting of an objective "sales target" forms the cornerstone of any programme of action, and upon its accuracy depends the success of establishing all other budgets.
- 2. The production capacity approach, which should be used where the knowledge of what is known as "production capacity" helps to formulate better ideas about desired results and understanding of expectation. The emphasis here is put on economic capacity utilisation.
- 3. The profitability approach, which should be used where the profit consciousness element is most noticeable. The knowledge of the break-even-point, and the understanding of the margin of safety will help management to make decisions concerning the future. The emphasis here is on margins of profits at varying levels of activity.

After determining the appropriate approach, which should be employed as the basis of the enterprise budget, management should prepare the enterprise budget starting with the key budget, which should differ according to the chosen approach. SIDEBOTHAM, mentioned that "a high standard of achievement of the "key budget" is essential if dislocation of the whole production activity of the firm is to be avoided". (24)

It must be remembered that the budget plan cannot be based on guess work without discussing the risk of stultifying the enterprise on which it is imposed. A carefully planned survey is essential, and it must be remembered that revision of the original budget should be carried out from time to time as a result of changes in conditions beyond the control of (25) management.

²³ A M HEGAZI. op. cit., p. 103.

R SIDEBOTHAM. "Accounting for industrial management" (Oxford, Pergamon Press. $\overline{1964}$)

R E GLEW. "Budgetary Control - Basic Principles". The Commercial Accountant Vol. XXI. No. 4. October 1970. p. 287.

The control function and budgetary control

The relationship between control and budgetary control has been explained by PEIRCE, he states:

"Control might be quickly and simply defined as a disciplined effort to follow a plan or explain deviations from it. The effort referred to take the form of self-discipline-voluntary, unified, and cooperative. The deviations from plan are deliberate, foreknown, and authorised. If they are apparently beyond anyone's ability to prevent - as for instance a failure to reach budgeted sales volume - at least they are spotlighted as early as possible, and management has the chance to take whatever action is indicated". (26)

On the other hand, WELSCH mentioned that processes of the control function necessitate, a) evaluating performance, b) comparing actual performance with objectives, plans, policies, and standards, c) analysing the deviation from such plans, policies, and standards, d) taking corrective action as a result of the analysis, e) following up to appraise the effectiveness of the corrective action, and f) feeding information back to the planning process to improve future cycles". (27)

COURT suggests that control can be achieved by two main methods: (28)

- 1. Direct supervision, by a responsible official with the requisite knowledge of the particular function.
- 2. Operating statements, setting out in financial and/or quantitative terms under a number of carefully coded and defined headings, the predetermined expenditure, the actual expenditure, and the variances between them.

In fact, control can be achieved with the above two methods together, because the supervisor will not be able to exercise control without information about the departmental performance, and the operating statement needs the supervisor who has the knowledge of the particular

^{26 &}lt;sub>J L PEIRCE</sub>, op. cit., p. 61.

²⁷ G A WELSCH, op. cit., p. 13.

²⁸ H P COURT, op. cit., p. 5.

function to take the necessary action and/or decisions. The point to emphasise is that control will only result from action taken by responsible people according to certain information presented to them. At the right time and in the correct form, the budgetary control technique aims at doing this. Therefore budgetary control presupposes a clear organisation structure which defines, the function of each supervisor and manager in the enterprise in order to present him with the correct information, and defines a clear line of responsibility and authority of each of them in order to identify responsibilities for any deviations from the approved budget; moreover, it assumes clear communication and an understanding of the budget by the different levels of management, because if a manager does not accept the budget as practical and achievable, it is logical that he will not try to achieve it or be responsible for its deviations.

It should be clear that without effective planning there can be no effective control, and conversely, without effective control planning is ineffective.

The purpose of budgeting in any enterprise is to provide yardsticks against which different levels of management can compare their performance and costs, and to achieve this a clear understanding of the purposes of budgeting should be indicated. LEWIS mentioned that the purpose of budgeting can be classified into the following categories, which are not necessarily sequential:-

- 1. The first category can be shown through the part budgeting process plays in integrating the activities of various functions within the enterprise. It provides a means which ensure that the enterprise objectives, production, and investments are reasonable and at the same time suitable for each other.
- 2. A related purpose of budgeting is to provide a communication device through which managerial employees can see how they contribute to intermediate goals of their function and also the goals of the business.
- 3. Another significant purpose of budgeting is to encourage consideration of profit planning which necessitates establishing profit objectives, putting monetary expressions on all the proposed activities of business, and deciding on the allocation of resources which present the best balance at a point in time.

4. The last category is to provide a means of measuring accomplishment against goals and, in this respect, the budget is an instrument of self-control, which requires the analysis of variances to determine the corrective action required. (29)

PILCHER, emphasised that budgetary control should attempt to achieve the following aims in an enterprise. (30)

- 1. To set out in quantitative terms the objectives of a firm, department, project or some sub-division of a business.
- 2. To enable comparison to be made between alternative plans for achieving different objectives to choose the best plan which should use the available resources.
- 3. To facilitate the coordination between the different sections of the enterprise in order to make the most efficient use of the limited resources.
- 4. To provide a guide to the level of achievement which is feasible for the enterprise.
- 5. To provide a plan against which the effects of action to connect adverse trends, or to take advantage of beneficial ones, can be measured both in performance and cost.

Budgeting and budgetary control became particularly important when delegation is high, and when enterprises are divided into divisions and sections.

The general objectives of budgetary control are to plan the policy of the enterprise, to coordinate its activities so that each section is a part of an integral whole, and to control each function within the enterprise so that the best possible results may be obtained.

R W LEWIS. "An industry view of budgeting" edited by R N Anthony,
J. Dearden & R F VANCIL. "Management control systems cases and readings"
(Illinois, Richard D Irwin, inc., Homewood. 1965) p. 73.

R PILCHER. "Appraisal and control of project costs". op. cit., p. 205.

The budget period

The exact period covered by the budget is conditioned by the natural periods for the business, such as the obvious one of the financial year, but occasionally it is necessary to break the annual budget down to monthly or even shorter operating periods. (31) It is not unusual to find a twelve-month budget broken down into four three month periods, being revised every three months, at which time a new twelve-month forecast is prepared. (32)

The budget period may also depend upon the production circumstances of the enterprise; in particular, on the length of the production cycle and the flexibility of the work installation. When the enterprise has a long production cycle, as for instance in the case of constructional engineering, a long period budget is most useful. On the other hand, if the production cycle is short, as is usually the case in light industry, the budget period might be as brief as three months. In the same way, the appropriate length of the budget period depends on the degree of flexibility of the production capacity. If the product range is capable of periodic variation, there is a merit in a short budgeting period, so that production might be quickly replanned to suit the new circumstances. On the other hand, if the plant is designed for rigidly invariable output, there is less advantage in short period budgeting. (33)

OWLER and BROWN, (34) mention that the control aspect is one of the aspects which determines the budget period, they explain:

"It is obvious that long period budgets cannot be effective means of controlling the business. Particularly is this so in respect of expenditure, which must be rigidly scrutinised at short intervals, usually monthly. It is therefore usually arranged that the budget period should be divided into short periods so that actual results can be compared with those budgeted; this ensures that if any adverse variances have resulted immediate action can be undertaken". (34)

³¹ R E C GLEW. op. cit., p. 288.

JESMITH. "Budgetary control in a medium-sized business". op. cit., p. 134.

³³ R SIDEBOTHAM. op. cit., p. 154.

L W J OWLER & J L BROWN. op. cit., p. 457.

From the above it is possible to conclude that the time period covered by the budget should be related to the necessity for, and the possibility of effective management action.

Types of budgets

Business budgets can be classified under the following headings:

- 1. Fixed budget, one which is prepared for one level of activity for a definite period of time. The basic characteristic of such a budget is that it is not adjusted to the actual level of activity when comparisons are made with a different level of actual activity. A fixed budget may be satisfactory when the enterprise activities can be estimated reasonably accurately. A fixed budget has a limited usefulness as a control tool. (35)
- 2. <u>Flexible budget</u>, is a budget which recognises the difference between fixed, semi fixed, and variable costs, and their relation to the level of activity attained. (36) The use of the flexible budget makes it possible to plan the departmental or the whole enterprise total costs at various levels of activity. Flexible budgets are a better tool for control than fixed budgets.
- 3. Appropriation budget, (38) this type of budget is encountered particularly in government operations or may be used in businesses in connection with advertising, capital additions, and/or research. The distinguishing characteristic of this type of budget is the limitation set on expenditures included in such budgets. The appropriation budget has a limited usefulness for business operations and sometimes the use of such a budget results in unwise expenditure of funds.

R I DICKEY. op. cit., p. 20.11.

L W OWLER & J L BROWN. op. cit., p. 473.

R LOWES. "Budgeting to meet problem of uncertainty". Management Accounting. Vol. 51. No. 1 January 1973. p. 11

³⁸ R I DICKEY. op. cit., p. 20.13.

An enterprise may use all these types of budgets at the same time. This use ranges from the development of a forecast budget all the way to the adoption of a complete budgeting and budgetary control system in which operation controls are incorporated.

A comprehensive budgeting system should consist of three types of budget:

- 1. The operating budget, which shows the planned operations for the forthcoming period. It usually consists of two parts: the first part is the programme budget which describes the major "programme" the enterprise plans to undertake, and the second part is the responsibility budget, which sets plans in terms of the persons responsible for carrying them out. The programme budget deals with the cost of products which may include costs which are not related to a particular department. On the other hand the responsibility budget for a department should show the costs which are controllable by the manager. Therefore, the responsibility budget can be used as a control device. (39)
- 2. The cash budget, which should ensure that the right amount of cash is on hand to operate the business, yet at the same time to ensure that no cash is lying idle. There are two approaches which can be used to prepare the cash budget, the first one starts with the budget balance sheet and the income statement and adjusts the figures to reveal the sources and uses of cash, and the second is to project directly each of the items that results in cash receipts or cash disbursements. (41)
- 3. The capital budget, which is a long term planning device for making and financing proposed capital outlays. (42) Management has to take decisions about the type of fixed asset to be acquired, and should arrange

R N ANTHONY. "Management Accounting Principles". (Illinoise, Richard D Irwin, inc., Homewood. 1971). pp. 357-358.

G RAY and J E SMITH. "Hardy Heating Co Ltd." (Sutton Coldfield, Midland Consultants Publication, 1973). p. 78.

R N ANTHONY. "Management Accounting Principles". op. cit., p. 371.

C T HORNGREN. "Cost accounting a managerial emphasis". Second edition (N J Prentice-Hall inc., Englewood Cliffs, 1967). pp 441-442.

the required finance for the purchase. (43) The capital budget is usually prepared separately from the operating budget and the approval of the capital budget does not constitute a final authority to proceed with the organisation of assets. For this authority, a specific authorisation request is prepared for each item spelling out the proposal in more detail, i.e. firm bids, price quotations on the new asset etc. (44)

The advantages and limitation of budgeting

The fundamental purpose of budgeting is to assist management to accomplish its basic functions, those of planning and control. RAY and SMITH explain the advantage of using budgeting in the enterprise by stating:

"The discipline of expressing plans in quantitative and monetary form represents an invaluable exercise since management is forced to face the future. The managers within a business are responsible for the effective use of capital allocated to them, and budgeting implies that proper plans are developed which will ensure this. Budgets act as a coordinating device and as a means of communication. Management becomes more aware of its various roles in the business, of overall and specific objectives. Perhaps more important than any of these points is the fact that standards of performance and cost have to be determined, and from the basis of planning". (45)

More specific advantages of budgeting have been given by WELSCH, they are:

- 1. It forces early consideration of basic policy.
- 2. It requires adequate and proper organisation that is, there is a definite assignment of responsibility for each function of the business.
- 3. It compels all members of management from the top down to participate in the establishment of goals.

G RAY and J SMITH. op. cit., p. 78

R N ANTHONY. "Management Accounting Principles". op. cit., p. 373-374.

 $^{^{45}}$ G RAY and J E SMITH. op. cit., p. 80.

⁴⁶ G A WELSCH, op.cit., p.21-22.

- 4. It compels all members of departmental management to make plans in harmony with plans of other departments.
- 5. It forces management to put down in cold figures what is necessary for satisfactory results.
- 6. It requires adequate and appropriate historical accounting data.
- 7. It compels management to plan for the most economical use of labour, material, facilities, and capital.
- 8. It instills in all levels of management the habit of timely, careful, and adequate consideration of all factors before reaching important decisions.
- 9. It reduces cost by increasing the span of control, hence less supervisors are needed.
- 10. It frees executives from many day-to-day internal problems through the media of predetermined policies and clear-cut authority relationships thereby providing more executive time for planning and creative thinking.
- 11. It tends to remove the cloud of uncertainty that exists in many firms among lower levels of management, relative to basic policies and objectives.
- 12. It pinpoints efficiency or its lack.
- 13. It promotes understanding among members of management of their co-workers' problems.
- 14. It forces management to give timely and adequate attention to the effect of the expected trend of general business conditions.
- 15. It forces a periodic self-analysis of the company.
- 16. It aids in obtaining bank credit.
- 17. It checks progress or lack of progress towards the objectives".

Budgetary control has its limitations when employed in an enterprise, RAY and SMITH state that:

"There are a number of dangers which need to be recognised and avoided. Budgetary control is essentially a short-period technique which provides useful assistance in the area of

management control and operational control. Concentration on the annual budget cycle, however, may lead to a neglect of strategic planning, which could be to the long term detriment of the company. Budgetary control is difficult to administer at times of rapid technological change and innovation, and there are dangers of inflexibility and constraints being imposed upon managerial action. Budgetary control can be a long, time-consuming and costly activity; consequently there may be pressure to take short cuts and avoid the difficult process of searching for the optimum usage of all resources." (47)

In the meanwhile, STAFFURTH, emphasised the weakness of budgetary control as a technique of planning and controlling the project costs in the construction industry. He gave the following reasons: (48)

- 1. Budgets are set up for departments or functions rather than projects.
- 2. Budgets are prepared independently of the physical programme of work, and hence the relating of cost control information to the physical progress is difficult.
- 3. Expenditure or liabilities to date are compared with the total budget figure, so that over and under spending are discovered near the end of the project life when it is late for taking corrective action.
- 4. When an attempt has been made to link physical progress to cost control, the assessment of progress has been subjective, or based on the proportion of allowed time or budget expended. Therefore, assessment of the budgeted value of completed work has been unreliable.

The Highways Department Budget

The county councils in the United Kingdon should establish a county annual budget which should cover the estimated expenditures and incomes of their different services. The annual budget is usually divided into a number of parts each representing one of the county council services.

G RAY and J E SMITH. op. cit., p. 80.

C STAFFURTH. Editor. "Project cost control using networks". (The operation research society". The Institute of Cost and Works Accountants. April 1969). pp. 13-14.

The Highways Department annual budget appears in the county budget in the form described in detail in Appendix Four. It consists of:

- a. The annual budget, which indicates the estimated expenditure and income of each type of road, location, and establishment in the Highways Department for the following year.
- b. The capital budget, which covers improvement work costing over a certain amount of money, and for buying equipment.

The Highways Department budget should be approved by the appropriate committees and also by the county council before being valid.

The Highways Department budget and the budgeting system

The Highways Department prepares its budget according to the estimated costs of its administration, the estimated costs of the maintenance and improvement work of the county roads, and the maintenance and improvement work of motorways and trunk roads. An estimate of the total cost of each of these operations is usually prepared, and the totals of each division's operations are added together to represent the estimated total costs of the improvement and maintenance work to be carried out by the division during the following year - assuming that the Highways Department budget is approved by the county council. The division's estimates of the operations' costs, the estimated administration expenditure, and the estimated expenditure for the central repair depot and central laboratory, should then be used to establish the Highways Department expenditure in the department annual budget. At the same time, an estimate of the expected income from the Department of the Environment, local government, and other income should also be determined and entered into the annual budget. difference between the estimated expenditure and income represents the total requirement for the Highways Department from the county council resources.

The capital expenditure budget is prepared according to an estimate of the total cost of the capital expenditure during the following year according to the same procedures as the county improvement and maintenance work. The county treasurer should be responsible for financing these projects.

The budgeting system, as described in brief above, does not represent a comprehensive budgeting system; it merely presents a departmental budget in cash budget form, and a capital budget in the form of a capital expenditure budget. The improvement and maintenance work estimates do not represent an effective operation budget which could be used as a medium for planning and control.

From the data obtained from the questionnaire used in the survey and the interviews with the appropriate personnel in the Highways Departments visited during the survey, one would conclude that the implementation of budgetary control techniques in those Highways Departments does not exist. (49)Therefore, it is suggested that the Highways Department should establish its budgeting system by concentrating on the operation budgets, and to avoid the weakness of budgeting as a medium for planning and control. The operation budget should be prepared from the cost units point of view, and as a programme of work. The cost units budget should also cover in detail all the cost elements required to complete the work in quantitative and monetary terms. There should be a relation between the cost unit budget, the programme of work, and the actual costing records in order to obtain maximum benefit from the budgetary control technique in the Highways Department. A cost centres budget should also be prepared to cover the different location of the Highways department, in the same manner as the cost units budgets. The Highways Department annual budget should then consist of the totals of the cost units and cost centres budgets.

The limiting factor of the cost units budgets

The Highways Department should carry out the maintenance and improvement work — to a certain value and size — by direct labour and by the county councils own plant, if available. It is assumed that, after the approval of the Highways Department budget by the county council, the availability of money to carry out the approved operations does not present a problem,

⁴⁹ See Appendix One

and therefore the availability of cash should not be the limiting factor in establishing the cost units budgets. It was suggested before, that the cost units budgets should be prepared in the form of programmes of work which necessitates accurate use of the available resources. In this case, the limiting factor for such budgets should be the availability of labour and plant, and therefore the "production capacity approach" should be employed in establishing the cost units budgets. This needs accurate estimates of the county council labour and plant normal capacity; the first can be estimated by the workstudy section, and the latter can be estimated by the central repair depot engineer. It is possible to include in the existing labour force capacity, extra capacity by using temporary workers, and, to add to the plant normal capacity, extra capacity by hiring some available items of plant.

The cost units budgets period

The Highways Department cost units budgets covers the maintenance and improvement operation which is divided into minor and major projects. The budget period for the cost units budgets differs according to the following manner:

1. The maintenance and minor improvement cost units budgets, represent operations which should be carried out and completed during the financial year. Their budget period should depend upon the time required to complete the work according to the programme of work, but, in order to facilitate the revision of the departmental budget, it is suggested that a three months divisional budget should be prepared, this to include all maintenance and minor improvement work scheduled in the programme of work to be completed during this period. The divisions budgets should then be added together, to present a three month budget for the Highways Department. Such a budget should help the county treasurer to determine the amount of cash required for each three months period; it should help avoid a rush of spending late in the financial year and should also help in revisions of the Highways Department budget.

2. The major improvement cost units budgets, represents the operations needed to carry out a major improvement project. This type of project is regarded as capital expenditure which is financed by government grant or loans. The budget period for the cost units, which the project consists of, should depend on the time needed to complete the work, however, the project budget should not be connected with the county council financial year. The periods of these budgets should depend upon the importance of the project, or, the availability of labour and plant, if it is decided that the project will be carried out by direct labour.

It is also necessary to prepare a divisional budget for these types of projects in the same manner as described before.

The cost units flexible budget

The cost units budget should be flexible. This means that the cost and quantities of each cost element should be compared with the appropriate cost and quantities for the achieved performance. In other words, it is necessary to adjust the original budget before comparing the actual and budgeted results, to ensure that the comparison is between the same level of capacity. The use of marginal costing theory, in calculating the cost unit costs, should help in using the flexible budgets for all the improvement and maintenance cost units.

The cost centre budgets

The cost centres budgets should be prepared for each cost centre, and will be described in detail in the following chapters.

The framework of establishing and distributing the Highways Department budget

It is suggested that the information needed for establishing the Highways Department should be sent to the control section at least three months before the beginning of the financial year.

It is necessary for this research to show the relationship between the different offices and sections, as suggested in the organisation structure, and the establishing and distribution of the Highways Department budget.

The type and amount of information which should be presented to, and distributed from, the control section may change from one county to another according to its circumstances, but, in general, it is assumed that in general this information is as follows:

1. Information required for establishing the budget

- 1.1 Information from the design office; this office should present the bill of quantities and the programme of work for all operations which should take place in the following year. The design office should receive information from the divisional construction engineers, the head office construction engineer, the surfacing engineer, and the works engineer.
- 1.2 Information from the traffic engineer; this office should present information about the traffic, road length, population, and the work load of each road to determine the required type of maintenance.
- 1.3 Information from the workstudy section; this office should present the measure of the input of the various maintenance and improvement operations, also the estimated production capacity of the Highways Department and each division.
- 1.4 Information from the cost accounting section and offices; this office should produce historical costs and/or rates of the components of the finished cost units and the previous year's cost centres.
- 1.5 Information from the purchasing office and stores section; this office should present up to date prices of materials and the payment terms offered by suppliers.
- 1.6 Information from the control offices in the central repair depot, and division; the divisional offices should present the suggested maintenance budget for the routine maintenance work in the division. The central repair depot office should present the suggested budget for the central repair depot.

- 1.7 Information from the plant engineer; he should present information about the capacity of the county council-owned plant, the availability of hired plant, and the capital expenditure required to replace the existing fleet.
- 1.8 Information from the administration department; this department should present the total administrative costs required for each location of the Department.
- 1.9 Information from the treasurers department; this department should provide details about the expected funds available during the following year.

After preparing and approving the Highways Department budget, the control office should distribute the appropriate parts of the budget to the different levels of management in the following manner:

2. The flexible budget distribution to the higher levels of management

2.1 The County Surveyor and his Deputy

The county surveyor is the head of the Highways Department. He should have a brief summary of: the expected divisional expenditure in maintenance and improvement work during the following years, the estimated cost of the major schemes in the county, the monthly targets of the working programme for each division, the amount of money which is expected to be spent on the replacement of plant, and the administrative budget for the department.

The deputy county surveyor should receive the same information but, as a result of his concern with the control of the work in the department, he should have this information in more detail.

2.2 The Head of Adminstration Department

The head of the administration department should have a copy of the Highways Department budget, containing the same information which was presented to the deputy county surveyor, and a more detailed budget about the administration cost in the head office, divisions and central repair depot.

2.3 The Head of Maintenance Organisation

The head of the maintenance organisation who is responsible for the divisions, the central repair depot, central laboratory, and the other offices in the Head Office should have a more detailed budget about the work in each division, this budget being classified into classes of roads. He should have a brief summary of the programme of work for each division which contains the target for all maintenance and improvement work in each division. He also should have a copy of the central repair depot and central laboratory budgets and their programmes of work.

3. The budget distribution to the head office sections and engineers

3.1 The Construction Engineer

He should have a complete budget for the major construction schemes which are approved and a brief summary of the programme of work.

3.2 The Surfacing Engineer

He should have a complete budget of all the surfacing work within the county, and a brief summary of the programme of work.

3.3 The Works Engineer

As the liaison with the district councils, plant utilisation, general correspondence with the public, training programme and the collection of information from the services section, are his responsibility, he should have a detailed copy of the county budget and programme of work.

3.4 Purchasing and Stores Section

All the materials budgets for all the county maintenance and improvement work schemes should be presented to the purchasing and stores section, accompanied by the programme of work for each project in order to make the necessary procedures for providing the materials at the correct time and place. The purchasing and stores section should have a list of the new plant which are needed

for the following period, in order to take the necessary procedure to order it. In other words, the section should execute the material and capital budgets of the Highways Departments.

3.5 Laboratory

The laboratory should be provided with the specification of all materials which will be used in the schemes in the county. If there are laboratories in the divisions depot, then each laboratory should have the specification of the materials which will be used in the division during the next period. The information should give full details of the materials for every scheme separately for easy identification.

4. The budget distribution to the divisional and the central repair depot staff

4.1 The control office in the divisions central repair depot and central laboratory

The divisional office should be provided with the budget of the maintenance work after approval, accompanied by the programme of work. Concerning work in the central repair depot and the central laboratory, the office should also be provided with the same information.

4.2 The divisional manager

As he has no specific functional responsibilities, other than making contacts with the public, he should have a summary of all the maintenance and improvement work and the programme of all the work in his division. He should also have a summary of the approved administrative budget for the depot as he is responsible for the administration and control of the depot premises and all the staff in the division.

4.3 The maintenance engineer

He should be provided with the divisional maintenance budget in detail. This budget should indicate the type of maintenance and the class of road, also the alternative work to be carried out in emergency or under any different conditions.

4.4 The construction engineer

He should be provided with the approved divisional construction budget which included all the improvement work in the division to be carried out in the following period together with the programme of work.

4.5 The maintenance supervisors

They should be provided with the programme of the maintenance work in the area they are responsible for.

4.6 The construction supervisors

They should be provided with the programme of the improvement schemes in the division.

4.7 The plant engineer

The plant engineer should be provided with: the over-all summary of the approved capital expenditure budget, the central repair depot budget (which includes the operations budget of the depot), the depot administration budget, and the work targets for the fitters in the divisional depots and workshops.

4.8 The deputy plant engineer

He should have: a detailed budget for the central repair depot (which includes the detailed operations budget), the work targets and the detailed administration budget of the depot which he is responsible for.

4.9 The supervisors in the workshops

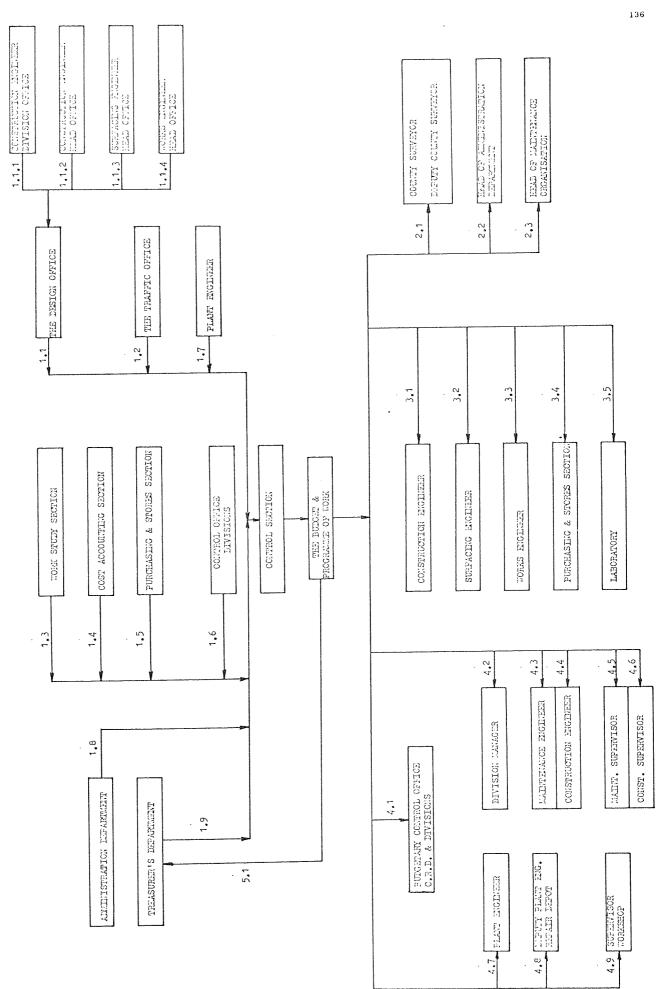
They should be provided with the work target of each form of work for every month.

5. The budget distribution to the other departments

5.1 The Treasurer's department

It should be provided with the over-all budget of the department as allocated to: the class of roads, the administration budget of the Highways Department and the capital expenditure budget.

Figure 5.1 shows the suggested framework of establishing and distributing the Highways Department budgets diagrammatically.



The suggested framework of establishing and distributing the Highways Department Budget

Fig. 5,1

CHAPTER 6

THE HIGHWAYS DEPARTMENT CAPITAL EXPENDITURE BUDGET

The Highways Department capital expenditure budget (1) covers the estimated cost of improvement projects, purchasing or replacing of plant and equipment, and all other types of capital costs.

The improvement projects capital expenditure budget

The expenditure required for the improvement projects represents a major portion of the Highways Department capital expenditure budget, which is financed by Department of the Environment grants, loans and /or contributions. The expenditure spent on road improvement projects is regarded as public investment which should yield a suitable return. Roads cannot be sold and there is no charge for using them, therefore the return on investment on roads should be measured with the aid of cost-benefit analysis. In this case, the returns which should be measured against the capital costs are divided into the following three categories (2)

1. Time saving, which constitutes something like 60% of the total benefit for the typical scheme. Current practice in this country is to categorise these savings as either working or non-working time; then the annual saving in man-hours so calculated is multiplied by the appropriate value of the time for each of the

The methods of financing the capital expenditure budget are beyond the scope of this research. This research assumes that there is a certain amount of funds available for capital expenditure, and the research therefore is limited to the problems which may affect the preparation of this budget.

DEPARTMENT OF THE ENVIRONMENT "Getting the best roads for our money - The COBA method of appraisal" (London, Her Majesty's Stationery Office, 1972) p.3.

two categories of user. The value of time saved in the case of working time is the appropriate wage rate of those affected with an addition for variable overheads, and it is valued at a percentage of the appropriate wage rate for non-working time.

- 2. Traffic benefit, which represents the saving in vehicle operating costs consisting of fuel, tyres, and general wear and tear of vehicles.
- 3. Saving in accidents, improved roads having lower accident rates. Accidents have to be predicted and valued to be included in the calculation; standard values have been in use in this country for this purpose for some time.

The formal method of investment appraisal carried out by the Department of the Environment is called "First year economic rate of return, "1st year ERR". One calculates this by simply dividing the first year's benefits by the cost of the project and expressing this fraction as a percentage. The "1st year ERR" calculated for road schemes is broadly comparable in principle with the interest rates from financial institutions. This method enables schemes that yield high traffic benefits in relation to their costs to be identified more clearly and implemented, and conversely those schemes that give poor returns to be postponed or rejected. The "1st year ERR" does not allow for variations in return, over time, to reflect in the assessment criterion, and this may effect the choice between different schemes (3)

A new method called COBA has been developed to replace the "lst year ERR" method. This method is in use at the Department of the Environment - including its regional offices and road units - for trunk roads which are the direct responsibility of the Secretary of State for the Environment. The COBA method calculates and discounts the costs and benefits of road schemes over an assumed 30 years, giving at the end the scheme's net present value and road incounting calculations.

³ Ibid. pp. 8-10.

make the use of a computer desirable. The use of a computer has enabled other important advances to be made, such as: the calculation of junction delays; major improvement in accuracy of calculations, the calculation of the benefits to traffic over complete years and in particular over the full 24 hours of each day, and bringing the input standards in line with the most recent research findings. The COBA method can provide a proper assessment of a set of projects which are related to each other in traffic terms and phased over time; it can also be used as a tool for planning during the whole design process of a scheme, this can be achieved by comparing between different solutions of design problems. COBA has its limitations; it is not applicable to very large schemes - completely new motorway schemes - or very small schemes - costing less than $\mathfrak{L}^{\frac{1}{d}}$ million. It does not include all the factors which can be relevant in questions of local economic development, and it does not incorporate the costs and benefits relating to the environment. However, COBA does enable the opportunity costs to be calculated for an environmentally favourable solution compated with the most efficient one for traffic, which can be used in decision making in the particular environmental situation. (4)

It is assumed that, for the time being, Highways Departments all over the country use the COBA method in choosing between different improvement schemes competing for limited available resources in the capital expenditure budget; if this is not the case it is recommended that the Highways Departments should use this method in choosing between alternative schemes.

The higher the ratio $\frac{\text{net present value}}{\text{cost}}$ expressed as a percentage, the more desirable is the scheme to be carried out. The Highways Department capital expenditure budget should include those schemes which are chosen according to this rule. The budget should be prepared in the control section after preparing the improvement project operational budget (5).

⁴ Ibid. pp. 11-17.

⁵ Details in chapter seven.

The plant capital expenditure budget

The capital expenditure required for purchasing and /or replacing plant should be determined through the plant capital expenditure budget which should be prepared by the central repair depot control office and approved by the plant engineer. The following factors should be taken into consideration when preparing the plant capital expenditure budget.

1. The economic life of plant

The economic life of plant has a significant effect on the calculation of the additional cash required as a consequence of making the new investment compared with the situation without it. Therefore it is important to determine the economic life of each type of County Council plant as accurately as possible in order to help the central office in preparing the capital budget according to the most economic costs.

The "Marshall Report" suggested that the use of the total equivalent present cost of expenditure for a certain period may be used as the basis for calculating the optimum replacement policy of plant, and presents the following example.

"A local authority proposes to purchase a lorry costing £3000, with the following maintenance and operating costs, and residual values,

Year	Operating costs including maintenance	Residual value at the end of the year
1	3000	2000
2	3500	1200
3	4000	750
4	4500	250
5	5000	100

It is assumed for simplicity that old lorries are scrapped at the beginning of the following year." (6)

The optimum replacement policy was determined by calculating the total equivalent present cost "EPC" of replacement policy every three and four years and it was concluded that the "EPC" of three years replacement policy is less than four years replacement policy. It was also mentioned that

Report of the Committee on Highway Maintenance, op. cit., p. 151

"A similar comparison between two year and three year replacement policies shows that the three year cycle has a lower equivalent present cost than two year cycles, and thus the three year cycle is the optimum replacement policy" (7).

To examine this result, calculation of the EPC of the five possible replacement policies based on ten year operations has been carried out in the same manner as suggested in the example, - Table 6.1. It is found from the results that the one year cycle policy has the lowest EPC.

To examine the validity of these methods in determining the economic life of plant, an example will be taken in which it is assumed that the lorry costs £5000, and studies of its operating and maintenance costs show that these are likely to be £550, £600, £800, £925 and £1000 for years 1 to 5. The resale price is estimated to be £4000, £3000, £2200, £1700, £725 respectively, and the interest rate is 10%.

The calculation of the EPC for four replacement policies - Table 6.2 - shows that the one year replacement policy also has the lowest EPC, then the two years policy, then the four years policy, accordingly, the one year cycle is the optimum replacement policy for this lorry.

After examining the results of the above two examples, one can conclude that the use of this method as presented by the "Marshall Report" does not help in determining the optimum replacement policy of plant accurately.

There exist a number of methods for determining the optimum replacement policy of plant. ACKOFF and SASIENI present a simple method of determining the life cycle of plant and how frequently it should be replaced This method necessitates the estimating of the resale price of the plant at the end of each year, and the running costs during the year. By adding depreciation (the difference between the initial price of plant and its resale price at the end of each year) to the total running costs during the suggested life of the plant, the total cost of the plant

⁷ Ibid. p. 151.

R L ACKOFF and M W SASIENI "Fundamental of Operation Research" (London, John Wiley & Sons Inc., 1968) pp. 204-205.

				····		-			***********			
rs	Equivalent present cost	0009	3182	3304	3380	3347	3726	1974	2052	2102	2078	31145
ement 5 years	Total cost	0009	3500	000+7	4500	0064	0009	3500	0004	4500	0064	
Replacement every 5 yea	Operating cost	3000	3500	7000+7	4500 4500	5000	2000 6000	3500 3500	0004 0004	4500 4500	2000	
K 0	Capital cost	3000				(100) 5000 4900	3000				(100) 5000 4900	
.2) 's	Equivalent present cost	0009	3182	3304	3192	. 8604	2173	2256	2180	2802	975	30162
ment(2 years	Total cost	0009	3500	4000	4250	9000	3500	0004	4250	0009	2300	
Replacement(2 every 4 years	Operating cost	3000	3500	4000	4500 4250	2000 6000	3500	0004 0004	4500	3000 6000	3500	
Re	Capital cost	3000	The section of the		(250)	3000			(250) 4500 4250	3000	(1200) 3500 2300	
(-	Equivalent present cost	0009	3182	2685	4506	2390	2018	3384	1795	1518	1696	25174
Replacement(2 very 3 years	Total cost	0009	3500	3250	0009	3500	3250	0009	3500	3250	0004	
place ry 3	Operating cost	3000	3500	4000	3000	3500	000t;	3000	3500	4000	3000	
Reple	Capital cost	3000		(220)	3000		(220)	3000		(750)	1000 *	
S	Equivalent present cost	0009	2091	4956	1727	4098	1428	3384	1180	2802	975	28641
nent years	Total cost	9009	2300	9009	2300	9009	2300	9009	2300	9009	2300	
Replacemen every 2 ye	Operating cost	3000	3500	3000 6000	3500	3000 6000	3500 2300	3000 6000	3500 2300	3000 6000	3500 2300	
Rej	Capital cost	3000	(1200)	3000	(1200)	3000	(1200)	3000	(1200)	3000	(1200)	
C.	Equivalent present cost	0004	3636	3304	3004	2732	7842	2256	2052	1868	1696	27039
ment year	Total cost	4000	000†	0004	4000	4000	4000	000+	000+7	0004	4000	
Replacement every 1 yea	Operating cost	3000 1	3000	3000	3000 4000	1000 3000 4000	1000 3000 4000	3000	3000	3000	1000 3000 4000	
Reev	Capital cost	1000 3000	1000 3000	1000 3000	1000	1000	1000	1000 3000	1000 3000	1000 3000	1000	
Discount Factor		1,000	606°	.826	.751	.683	.621	495.	.513	294°	454	TOTAL
	Year	-	2	М	7	77	9	7	∞	6	10	

1. A 10% discount factor as the central government rate see Appendix 5. 2. Calculation of "Marshall report" example.

Capital cost, less residual value of £2000 of the first year.

6.1

TABLE

TABLE 6.2

during its life can be found by dividing this total over the number of years, and the estimated cost per year can be obtained. Thus, by comparing these annual costs, the replacement should take place at the end of the policy which has the lowest average cost per year. This method assumes that the plant will be replaced by a similar item and will be needed for an indefinite period in the future.

Using the figures of the previous example, the optimum replacement policy for the lorry can be determined through the following calculation:

Age at replacement Costs	1	2	3	4	5
Total running cost Depreciation	550 1000	1150 2000	1950 2800	2875 3300	3875 4250
Total cost	1550	3150	4750	6175	8125
Cost per year	1550	1575	1583	1544	1625

As a result of this calculation, it seems that the lorry should be replaced at the end of year four, in other words, the optimum replacement policy for this type of lorries is a four year cycle.

ACKOFF and SASIENI, also present a method for determining the optimum replacement policy to be used when the plant is needed for a limited period and there is an existing item in the enterprise (9).

In this case, the total cost of the plant should be calculated starting from the age of the old item; depreciation should be calculated as the difference between the resale price at the age of the old item and the resale price at the age considered, this total cost should be added to the cost of a new item of plant for the balance of the limited period.

⁹ Ibid. pp. 205-206.

If the figures mentioned in the previous example are used, but the lorry is needed for only six years and the enterprise has one year old lorry, the optimum replacement policy can be calculated as follows:

Age of replacing the old lorry	2	3	4	5
Running costs Depreciation	600	1400 1800	2325 2300	3325 3250
Cost of present lorry Cost of new lorry	1600 6175	3200 4 7 50	4625 3150	6575 1550
Total cost	7775	7 950	7775	8125

According to this calculation, the optimum replacement policies which have the lowest cost, are either replacing the lorry at age four or at age two and buy a new one for the remaining periods.

BAXTER, presents the "least common multiples" method for determining the economic life of plant (10). This method ignores all fixed costs, which represent all costs which will not be changed by altering the life span of the plant, but, the initial costs, which may seem to be fixed according to this assumption, is regarded as variable. The net relevant cost or the average cost per year over the possible lives should be calculated and the cycle with the lowest total or annual average cost should be the economic life of the plant. The previously mentioned example will be used to illustrate this method, assuming that the lorry is required for twelve years.

W T BAXTER "Depreciation" (London, Sweet & Maxwell 1971) pp. 6-13.

life span of	1 year	2 years	3 years	4 years	5 years
Initial cost	5000	5000	5000	5000	5000
Recurring costs (variations)					
During year 2		50	50	50	50
During year 3			150	150	150
During year 4				375	375
During year 5					450
Total	5 0 00	5050	5200	5575	6025
Less resale price	4000	3000	2200	1700	750
Net relevant cost, l machine	1000	2025	3000	3875	5275
Net relevant cost for 12 years	12000	12300	12000	11625	13600
Average per year	1000	1025	1000	.969	1055

The previous methods lumped together moneys of different times without making any adjustment for the time value of money. This is not right in principle, and may cause errors in practice. The cost of capital should be included in the calculations. The following are some of the existing methods which include the cost of capital in determining the optimum replacement policy of plant.

BAXTER, mentioned that the simplest method is drafted on the lines of the averaging example above. The total costs should be calculated with the items discounted to date "zero", then re-express each of these present value totals as an annual equivalent costs. The life with the smallest instalment is the cheapest and should represent the optimum replacement policy (11). Using the same example, the economic life of the lorry should be determined through the following calculation.

Instalments calculated according to this method are bigger than the simple averages calculated according to the previous method, because interest on the total net costs is recognised as an extra cost, but the increase is not uniform for all possible economic lives of a given plant, and may change the optimum life i.e. tending to lengthen it. Ibid. pp. 13-15.

life span of	l year	2 years	3 years	4 years	5 years
Initial Cost	5000	5000	5000	5000	5000
Recurring costs "discounted" *					
During year 2		41	41	41	41
During year 3			113	113	113
During year 4				256	256
During year 5	Liver property of the control of the				279
TOTAL	5000	5041	5154	5410	5689
Resale price discounted *	3636	2478	1652	1161	465
Net relevant cost (discounted) *	1364	2563	3502	4243	5224
Annual equivalent cost	1500	1476	1407	1340	1377

According to this calculation, the four years cycle represents the optimum replacement policy for replacing the lorry.

Another method of determining the economic life of plant has been described by HARPER, he states:

"Determining the optimum replacement date (other things being equal) involves finding the net present value to eternity for every practical replacement cycle and identifying the cycle that minimises the discounted cost." (12)

To discount an infinite number of recurring cycles the following formula should be used.

W M HARPER "Discounting to eternity" Management Accounting. Vol 48, No.12 December 1970 pp. 441-446.

^{*} The discount factor appendix 5 and capital recovery factory appendix 7.

Present value of £1 at the end of n years.

The determination of the economic life of the plant according to this method should be determined as illustrated in Table 6.3, where the following data are included.

1. The number of years.

PVn

- 2. The estimated expenditure per year.
- 3. The estimated resale price of the item of plant at the end of the year.
- 4. The discount factor, according to the rate of interest Appendix 5.
- 5. The present value of the estimated annual expenditure.
- 6. The cumulative total of the present value of the estimated expenditure.
- 7. The present value of the resale price.
 - 8. The net present value of the cycle.
 - 9. The value of (1 discount factor) Appendix 6.
- 10. The net present value of the cycle discounted to eternity.

From Table 6.3 it is seen that the lorry should be replaced after the fourth year, as the net present value discounted to eternity is the lowest; this means that the economic life of the lorry is four years. This table is not necessarily prepared to cover the whole series of the life cycle, especially if it is a large one. The table should only be prepared to cover the life cycle of the plant for the periods which show a significant increase in the maintenance and repair costs. The use of the discounting to eternity method does not make any allowance for inflation as in an inflationary situation costs and income, in the long term, rise together and so cancel each other out. (13)

¹³ Ibid. p.443.

P.V. to eternity	(10)	- 20605 - 20259 - 19875 - 19135 - 19475
1-Discount factor	(9) Appendix 6	0.0909 0.1736 0.2487 0.3170
N.P.V. cycle	(8) 6 x 7	- 1864 - 3517 - 4943 - 6066 - 7383
Present value of resale price	(2) 3 x 4	5000 3636 2478 1652 1161 465
Cumulative total of present value of expenditure	(6) (Total of Col 5)	- 5000 - 5500 - 5995 - 6595 - 7227 - 7848
Present value of expenditure	(5) 2 x 4	- 5000 - 500 - 495 - 600 - 621
Discount factor 10%(1)	(4) Appendix 5	1.000 0.909 0.826 0.751 0.683
Resale price	(3)	5000 4000 3000 2200 1700 750
Cash expenditure	(5)	- 5000 - 550 - 600 - 800 - 925 - 1000
Year	(3)	0 - 0 W 4 W

PABLE 6.

It is recommended that the economic life of the central repair depot plant can be calculated according to one of the above methods, but is is proposed to use the methods which include the cost of capital into consideration. (14)

2. The optimum size of plant fleet

The optimum number of items of plant which should be kept in the central repair depot is another factor which affects the capital budget, as it is according to the optimum number of each type of plant compared with the actual number kept in the central repair depot, that a decision to buy a new item may be taken; this affects the capital expenditure budget. This factor is also important to the plant engineer, who should determine how often to hire an item of plant, as it may be worthwhile to do so even when the hire charges payable exceed the central repair depot internally allocated charges.

The National Coal Board Field Investigation Group, during their studies of small railway systems, tried to find out the right size of the wagon fleet, for, if the fleet is too large the wagons utilization will be small, whereas if the fleet is too small, wagons need to be hired at extra cost. A simple rule, to assess what is the right size, has been presented by the group and it reads,

"If hired wagons are K times as expensive as owned wagons, then wagons should need to be hired on 1 day every K days" (15)

If wagons are replaced with any type of plant in the central repair depot, the optimum size of plant which should be kept in the central repair depot can be determined. The use of this rule necessitates the

¹⁴ For further methods of replacement see:

⁻ B.V. DEAN "Replacement theory" Edited by R I ACKOFF "Progress in operation Research" Vol. 1 (London, John Wiley & Sons, Inc. 1966) pp. 328-362.

⁻ THE INSTITUTION OF CIVIL ENGINEERS "An introduction to engineering economics" (London, 1969) pp. 64-69.

D KIRBY "Letter to the editor" Operation Research Quarterly Vol. 10, No. 4, December, 1959. p. 252.

estimating of the owned plant annual cost including depreciation, interest on capital, maintenance etc., and the number of items of plant required for each working day over the year (16).

If for example, the annual cost of the County Council excavator is £1200 per year, and the number of excavators required during a year of 200 working days is as follows:

No. of	excavators required	No. of days required this
on	each working day	number of excavators
	1	50
	2	40
	3	25
	4	5 O
	5	35

If the hired rate of a similar excavator is

(A) £8 and (B) £14 (two alternative quotes)

then what would be the optimum number of excavators which should be kept in the central repair depot in each of these cases?

The central repair depot internal rate per day = $\frac{1200}{200}$ = £6 per day therefore, in case A, the hired excavator is 8/6 times as expensive as the owned excavator. This means that it should be hired 6 days every 8 days, or on 200 x $\frac{6}{8}$ = 150 days per year. And according to the annual requirement of excavators during the year, the remaining 50 working days can be fulfilled by keeping one excavator in the central repair depot.

In case B, where the hired rate is £14, the excavator should be hired on $200 \times \frac{6}{14} = 85$ days per year, and the remaining 115 working days can be fulfilled by keeping 3 excavators in the central repair depot (17).

¹⁶ Methods of estimates will be described in the following chapters.

The plant engineer may recommend that some extra items of plant should be kept in the central repair depot in order to provide an excess availability of these items, or because a special type of plant is not usually available from plant hiring firms although it may not be used economically. On the other hand he may recommend hiring plant rather than buying as a result of non-availability of skilled drivers or operators, and/or because of the inefficiency of repairs in the central repair depot.

The use of this rule facilitates the procedures required to determine the optimum number of each item of plant and this should lead to an optimum size of plant fleet in the central repair depot. In fact, this rule substitutes the long calculation which is illustrated in Table 6.4 and gives the same results. The calculations confirm that it is cheaper to have one or two excavators when the hired rate is £8, and three excavators when the hired rate is £14. This method does not require complete accuracy, in determining the annual cost of plant, as a small percentage deviation in the plant annual cost, and accordingly in the allocated rate per day, does not affect the final results; the same remark applies to the determination of the number of days required for the different number of plant.

The assessment of plant ownership requirements should take place every year according to the anticipated demand in relation to owned and hired plant and purchase prices of new items.

3. The allocation of funds

The allocation of the available funds represents another factor which should be considered when preparing the capital expenditure budget, as the available funds may not be able to accommodate all items of plant required during the year. The use of the Expenditure Priority Index, EPI (18), should be considered as the basis of choosing the items of plant which should be included in the budget.

The Expenditure Priority Index of each item of plant can be determined by calculating the equivalent present costs for alternatives - buying a new item or hiring it, or replacing an item of plant now or after one year etc. - then EPI is calculated as follows-

EPI = Difference in total present equivalent cost between alternatives

Difference in present year expenditure between alternatives

¹⁸ Report of the Committee on Highway Maintenance. op. cit., p. 144.

- Landerson		AI		0	0		0		0
	·	TOTAL		0009	5290	5280	5620	6520	8120
Hiring charge £14 per day	i de la composition della comp	Total	બ્ર	ı	064	1630	3220	5320	8120
	cost	Rate per day	લ્સે	14	1/4	14	14	14	14
	Hiring cost	No. of days required hiring		ŧ	35	120	230	380	580
Hiring		Total	æ	0009	4800	3600	2400	1200	
	Owning cost	Annual cost per item	ಈ	1200	1200	1200	1260	1200	
	Owni	No. of Plant		ſΛ	4	2	2	<u>_</u>	
		TOTAL		0009	5080	4560	4540	4240	0494
, day	cost	Total	¢13	ı	280	096	1840	3040	0494
£8 per day		cost	Rate per day	લાકે	∞	∞	∞	∞	8
Hiring charge	Hiring	No. of days required hiring	order der röger von der der der der der der der der der der	ı	35	120	230	380	580
H		Total	લ્ફ	0009	4800	3600	2400	1200	i
	Owning cost	Annual cost per item	ಡಿ	1200	1200	1200	1200	1200	1
	Own	No. of Plant		Ŋ	7	2	2	_	0
Number of Excavators owned			2	. 4	М	2	~	0	

TABLE 6.4
COST OF OWNING AND HIRING
EXCAVATORS

If, for any given comparison, there is more than one alternative with identical minimum present year costs, the calculation of EPI should be based on the one with the lowest present cost (19). After calculating the EPI for all the considered items of plant, the higher the EPI the more desirable the item to be considered for inclusion in the capital expenditure budget (20).

The capital expenditure budget for the central repair depot should be prepared after considering the above factors, and it is suggested that the budget should be prepared in detail, in the central repair depot control office, in the form shown in Figure 6.1. This budget should then be sent to the control section who should be responsible for preparing the capital expenditure budget for the whole department.

^{19 &}lt;u>Ibid</u>. p. 145

For examples about the use of EPI see <a>Ibid. pp. 151-156.

Remarks		
Recommended	•	
Suggested Delivery Date		
Estimated	£ D	·
Expenditure Priority Index	"EPI"	
New or Replaced		
Plant Description		•
Plant Cost Centre	Code No.	· ·
No.		

Figure 6.1

THE PLANT CAPITAL EXPENDITURE BUDGET FOR

THE CENTRAL REPAIR DEPOT

CHAPTER 7

THE COST UNIT BUDGET AND PROGRAMME OF WORK

According to the cost unit codes, the cost units within the Highways Department have been divided into maintenance and improvement operations. An operational budget should be prepared for each of these operations in the form of a programme budget to facilitate comparisons, ensure better utilisation of resources, and facilitate effective control.

The Bill of Quantities, which is usually prepared for all types of construction work, is sometimes used as a substitute for the operational This may seem to be reasonable because the priced Bill of Quantities tends to be an estimate of the quantities and costs of the works which should be performed; but upon examining what the Bill of Quantities means, one finds that it is intended in the first instance to give information upon which tenders can be obtained. When a contract has been entered into, the function of the priced Bill of Quantities is to provide for the valuation of the work executed. In the Bill of Quantities, the headings and item descriptions identify the work covered by the respective items, but the exact nature and extent of the work to be performed is ascertained by reference to the drawings, specifications and conditions of contract, as the case may be, read in conjunction with the matters listed against the relevant marginal headings "item coverage" as described in the Department of the Environment "Method of Measurement for Road and Bridge Works". The rates and prices entered in the Bill of Quantities are deemed to be the full inclusive value of the

work covered by the several items including the following, unless expressly stated otherwise in the aforementioned Method of Measurement:-

- 1. Labour and all costs in connection therewith.
- 2. The supply of materials, goods, storage and costs in connection therewith.
- 3. Plant and all costs in connection therewith.
- 4. Fixing, erecting and installing or placing of materials and goods in position.
- 5. All temporary work.
- 6. The effect on the phasing of the works of alteration or additions to existing services of statutory undertakings, the Post Office, and the extent that such work is set forth or reasonably to be implied in the document on which the tender is based.
- 7. All general obligations, liabilities and risks involved in the execution of the work reasonably implied in the documents on which the tender is based.
- 8. Establishment charges, overheads and profit. (1)

The Bill of Quantities may be prepared as shown in figure 7.1. (2)
The contractors should enter their rates and prices against each item of the Bill of Quantities; a copy of the Bill of Quantities may be sent to the consturction engineer in the head office to price the bill and to compete, on behalf of the Highways Department, against the contractors, according to certain limitations on the total value of the project and the availability of labour and plant in the department. These limitations differ from one county to another.

DEPARTMENT OF THE ENVIRONMENT "Method of measurement for road and bridge works" op. cit., pp. 2-11

This example is from a Bill of Quantities of an improvement project prepared by one of the counties taking part in the survey.

- Ref 1954 GE 10070	resta vito de a referencia.			<u> </u>	
Code Item No.	Description	Quantity	Unit	Rate	Total
1.	Preliminary items				
1.1	Provide, erect and maintain all necessary temporary illuminated traffic signs including cost of lighting		Item		
•					
1.3	Provide temporary diversion ways and temporary works		Item		
:					
1.5	Provide for the setting out of the whole of the works including all necessary labour, instruments and materials		Item		
:	-				
2.	Site clearance				
2.1	Clear away all undergrowth brushwood, bushes, shrubs and small trees up to - girth. Grub up roots and burn or dispose of from site		sqm		
3.	Fences, Hedges and Accommodation Works				
3.1	Concrete post and chain link fencing to British Standard No type - with three lines of barbed wire supported on extension arms as shown on the drawing		sqm		
4.	Surface water drainage				
4.1	Excavate trench in common excavation, provide lay and joint extra strength concrete pipes to B.S. No include for - m granular bed and haunch and back filling, - m dia; depth to invert exceeding - m but not exceeding - m.		m		
	- m dia; depth to invert exceeding - m but not exceeding - m.		m		
:					
1				,,	

			1.1	7()
5.	Earth work			
5.1	Excavate top soil to the depth directed but not exceeding and store for re-use	cum		
:				
5.4	Excavate cutting in all suitable materials other than solid rock to the levels shown on the drawings and form embankments fill areas directed	cum		
:				
6.	Carriageway			
	A. Flexible Construction			
5A.1	Provide, spread and consolidate on formation beneath carriageways approved typesub base material to a compacted thickness of - m.	sqm		
•				No.
6A.6	Provide lay and roll in two equal layers to a total compacted thickness of - Rolled Asphalt (hot process) base having an esphaltic cement to B.S. No aggregate content of -%.	sqm		
	B. Composite Construction			
6B.1	Provide lay and compact leam concrete base with - m maximum size aggregate to compact thickness of - m including all forms, curing, blinding and cleaning off loose material before laying bituminous materials	sqm		
	mater tate			
,	t e e e e e e e e e e e e e e e e e e e			

Figure 7.1

The Bill of Quantities for an improvement project

If the Highways tender is successful, one or more of the construction gangs in the appropriate division should carry out the work, and the Bill of Quantities will be used for the valuation of the work executed. In other words, the Bill of Quantities is used as a budget and the actual costs should be compared with the estimated costs in the Bill, the variances then being reported to the different levels of management to take the appropriate action to correct the situation.

From this summary of the contents and procedures of the Bill of Quantities one can conclude that there is no relationship between the Bill of Quantities and the programme of work and this may affect the accuracy of the variance reports. The Bill of Quantities include inclusive rates and prices which cover the many elements of cost, and the details of their calculation are not usually available to the control and cost accounting sections, and this makes it impossible to prepare variance reports (including an analysis of variances) which identify the causes of the variances and help managers in taking corrective action. The Bill of Quantities as a result of these limitations is not a substitute for the operational budget; it is only an approach for competing between several contractors to determine the low priced tender for the construction engineering projects.

The Building Research Station devised an operational Bill of Quantities to overcome this limitation. It is aimed at improving contractual procedures. The work involved in the construction project is broken down into stages of work or operations which become the units of estimating the cost of labour. Each operation is a section of work that can be carried out by a gang of men as a task, without interference by the otheroperations. A precedence diagram is used to show the relationship between the various operations.

The operational Bill consists of a written document, including the precendence diagram as a frontispiece, and a set of working drawings. It is printed on coloured paper and comprises a number of sectional Bills, and in order to supplement written information in the Bill, line diagrams are printed on pages facing the operations description. L M FORD "Notes on Bill of Quantities" The Civil Engineering Department. The University of Aston in Birmingham. 1973 p.1.

HYDES and RHODES recognised these limitations and the need for a new type of Bill of Quantities, they stated:

"The traditional Bill had little value other than as a means of comparing tenders. However a Bill which was itemised in direct relationship to an associated network was a valid control document in its own right." (4)

The suggested operational budget should be prepared for each operation, and should consist of material, labour, plant, and/or constracts schedules. The cost units and cost elements codes should be used in schedules to identify the operations and the cost elements. This will facilitate comparisons between actual and estimated costs.

1. Materials schedule

This schedule should comprise detailed information about all types of materials needed for the operation; quantities measured in the appropriate units, rate per unit, and costs of materials and haulage. These should then be distributed over the estimated duration of the operation on a weekly basis according to the programme of work - Figure 7.2 - represents the suggested material schedule.

2. Labour schedule

This schedule comprises the description of the work, the estimated man/hours, and the cost of such work. The description of work should cover all the manual work to be carried out by the gang in items, and against each item, the estimated man/hours and cost of labour being recorded. The latter should then be distributed over the duration of the operation on a weekly basis.

The description of work should be prepared in the same manner as the road work specification prepared by the work study section. This specification should include the method of working, the gang size and grade of workers, and the number of man/hours needed to execute the

W S HYDES and F C RHODES. "Resource allocation and production of estimates" The Highway Engineer, December 1973. p.23

Iter Cod. No.	Road No: Operation Code No: "Cost unit" Code Description of materials Unit Quantities	Cost of Materials Price Per Unit	als. Cost	Cost of Materials Price Per Cost	of rials Cost	Total	Cost of Materials Total Cost Per Cost Cost	₩ ₩ ₩ ₩	Д Д	Esti Star Fini	Estimated per. Starting day Finishing day Week Week 2	Estimated period: Starting day: Finishing day: Week Nu	period: ay : day : Week Number H Q	W Week	M	days 19 19	Week M	
	Total cost				A SECURITY OF THE PARTY OF THE		The state of the s	the state of the s							2 2 3 3 4 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2			

Figure 7.2 Material Schedule

Q = Quantities
M = Cost of materials
H = Cost of haulage

PONTAGE TO SO DESIGN

operation. The estimated cost should be divided into the components of labour costs as classified in the cost element code - appendix 3. The rate per/hour should be determined according to the grade of workers, and the bonus calculations at the predetermined performance which is regarded by the work study section, the control section, the head of divisions, and the divisional engineers as a suitable and fair performance for the ordinary worker all over the year. Figure 7.3 represents this schedule.

3. Plant schedule

The plant schedule should include information about the items of plant required for the operation. These items should be determined after consultation between the divisional engineer, work study section, and plant engineer. The source of plant - county council plant or hired plant - should be determined according to the plant cost centre annual programme of work. The rate per/day or hour - to be determined according to the type of plant - should be recorded in the schedule according to the estimated rate calculated by the central repair depot control office, or the accepted tenders for hired plant. The estimated weekly working hours and their costs should be shown separately in the schedule in the same manner as described before. Figure 7.4 presents the suggested plant schedule.

Having calculated the pay performance, reference is then made to a table of bonus payments indicating the amount of bonus to be paid for each worker in the gang.

The calculation of bonus, as carried out in one of the counties taking part in the survey is as follows. The standard minutes values of the road work specification for road work has been prepared; these are applied to the controlled work executed by gang or individual roadman. The standard minutes earned by the gang during the week are calculated (S), the number of man/minutes spent on uncontrolled work are totalled and the number of credit minutes calculated (U). The number of man minutes of lost time are totalled and the number of credit minutes calculated (L). The total number of actual man/minutes worked by the gang is calculated (A). From this the pay performance of the gang or an individual can be calculated by using the following formula $pay performance = \frac{S + U + L}{A} \times 100$

⁶ See Chapter 8 and Appendix 9.

			COST				
		WEEK	등 등 등 등 등 등 등 등 등 등 등 등 등 등 등 등 등 등 등				
		L.A.					
: *		WEEK	NO. OF HRS				
ESTIMATED DURATION: STARTING DAY: FINISHING DAY:	LEBER	.	COST				
TED DU NG DAI	WEEK NULBER	WEEK	NO. OP HRS				
ESTIMATED DURA STARTING DAY: FINISHING DAY:	71	Ä	COST				
Ed 10 Ed		WEEK	NO. OFF	<u> </u>			
		WEEK	COST				
		WE	NO. OF HRS.				
		TOTAL	COST				
	COST	1	COST RATE	·			
		PEPLOY-	S COST	ingt			
		E E E	T RATE				
DULE:		BONUS	E COST				
LABOUR SCHEDULE NO: DESCRIPTION:		PS PS	ST RATE				
LABOUF NO: DESCRI		JES CAL		DESCRIPTION:		WAGES	E COST
		<u></u>	ir Rate				
		of MAN	, HOUR	We a state of a st			
		WORKE GRADE	R				
		×					
s NO:		DESCRIPTION					
NO: T CODE		DESC		Acceptable in the control of the con			
ROAD NO: PROJECT NO: COST UNIT CODE NO:	<u></u>	—————————————————————————————————————					
RO1		CODE NO:		· · · · · · · · · · · · · · · · · · ·			

FIGURE 7.3 LABOUR SCHEDULE

		WEEK	COST	
		I.I.	NO. OF	
·		M	COST	
ESTIMATED DURATION: STARTING DAY: FINISHIK3 DAY:		WEEK	BBS 品S	
DURA' DAY: DAY:		M	COST	
ESTIMATED DURA STARTING DAY: FINISHINJ DAY:		WEEK	MO. OF HRS	
ESTI STAR FINI:			COST	
	MEER	WEEK	MO. OFF	·
	WEEK NOWEER		COST O	
	WI	VEEK	MO. OF CO	
		<u> </u>	-	
		Web W	COST	
			NO. ST OF	
EINCE		WEEK	COST	
SCHE	8-1-T		S S S S S S S S S S S S S S S S S S S	
PLANT SCHEDULE NO:	COST		THOTA	
		HIRE	PLANTPLANT, PLANTPLANT	
		Ü	PLAN	
	E IOUR	HERE	PLAMT	
	RATE PER HOUR	υ. υ	PLANT	
		F WOI	RING JRS	
		F PL		
		N.C		
DE NC		IPTI (·
ROAD NO: PRCJECT NO: COST UNIT CODE NO:		DESCRIPTION		
ROAD NO: PRCJECT NO: COST UNIT C	E			
RO.	PLANT CODE NO:			

FIGURE 7.4 PLANT SCHEDULE

4. The contract work schedule

The Highways Department is not responsible for planning or controlling the contract work; therefore, the contract work schedule should only include the estimated total cost of each item of work, and detailed information about the time allowed for executing the contract, and the different conditions included in the final contract. This schedule may be used for more than one operation if it is carried out by the same contractor, and included in the same Bill of Quantities and final contract. Figure 7.5 represents the suggested schedule.

The operation budget

The operation budget should consist of one or more of the above-mentioned schedules - according to the nature of the operation.

The operation schedules should be accumulated in the operation budget - Figure 7.6 - which should also be used for a large improvement scheme consisting of a number of operations.

The Bill of Quantities developed by HYDES and RHODES, and described in their article (7) should facilitate the preparation of the aforement-ioned operational schedules, and operation budgets.

The programme of work and budgetary control

From the previous discussion it is concluded that the operation budget should be prepared as a programme of work to overcome the major weakness of budgeting in the construction industry. There exists a number of methods which can be used for construction planning. These methods are:

I The work schedule chart

In the mid-nineteenth century at least one writer discussed a "work versus time" graphical representation similar to today's bar chart. However, it remained for HENRY L GANTT and FREDERICK W TAYLOR, in the early 1900's, to popularise their graphical representation of "work versus time". These 'Gantt charts" were the basis for today's "bar graphs" or "bar charts". The work of GANTT and TAYLOR was the first

 $^{^{7}}$ W S HYDES and F C RHODES, op. cit., pp.24-26

		Minimum amount of Third Party insurance	•	
- ν.ψ.ψ. ν.φ.		Time of payment after Certif-cate		
Starting dates 1		Minimum Amount of Interim Certif-	•	
Starti	ions	Limit of Reten- tion Money		
	Conditions	Percentage of Retention		
hedule		Period of Mainte- nance		
Contract work schedule		Amount of liquidated damages		
OO N		Time for Comple- tion		
		Total		X
		Name of Contractor		
de No: No: on No:		Description		
Road Code No: Project No: Operation No:		Operation Code No.		

Figure 7.5 The Contract Work Schedule

thedeling

	·	- 0			ı
		Remarks			
		Contract Work Schedule	-		
	Alle er er er er er er er er er er er er er	Plant Schedule			
		Labour Schedule			
Operation No:		Materials Schedule	:		
Ope Scł		Total Cost	·		+
		Description of Operation		Total costs	
	Road Code No:	Schedule No			
		Operation Code No.			

Figure 7.6 The Operation Budget

1. Tick the inappropriate

scientific consideration of the problem of work scheduling. Although work was originally aimed at production scheduling, it was readily accepted for planning construction and recording its progress. The bar chart was, and still is, an excellent graphic representation of activity. It is easily read and understood by all levels of management and supervision. Figure 7.7 represents a simple bar or Gantt Chart having a horizontal time scale and the requisite operations listed vertically on the left hand side. A horizontal bar against each operation indicates the period of time over which the operation is scheduled.

A comprehensive study of the advantages and disadvantages of the bar chart, as a means of displaying the results of planning and scheduling, has been carried out by PILCHER, and the following is a summary of his study $^{(9)}$.

1. The advantage of the bar chart

- 1.1 It is cheap and simple for medium and small contracts.
- 1.2 It is well-tried method which is familiar to workers in the construction industry.
- 1.3 It provides an adequate means of displaying the basic outline information required in order to control work, e.g. drawing and design requirements, sub-contractors attendance, etc.
- 1.4 It provides a simple means of establishing resource requirements per unit time and for smoothing or levelling these in a crude fashion for relatively small, simple and unsophisticated programmes. (The length of the bar for each operation is determined by dividing the total production required by the rate of production, and resources can therefore readily be calculated).

J J O'BRIEN "CPM in construction management" (New York, McGraw-Hill Book Company 1965), pp. 3-4

R PILCHER "Budgetary and cost control for Civil Engineering construction allied to modern methods of programming" (Unpublished M.Sc. Thesis. Loughborough University of Technology, 1966) pp.13-17

- 1.5 The adoption of a 4-week month on the horizontal scale of the chart simplifies the scheduling arithmetic. It also provides a margin of approximately 8% to cover any scheduling errors, bad weather, etc. It is an admissible advantage within the limitation of the method in general.
- 1.6 Progress can be reported upon by adding information to the original chart and as such it provides a graphical means of reporting, often more acceptable to the busy executive than a superabundance of tabulated data.

2. The disadvantages of the bar chart

- 2.1 It is necessary to carry out the functions of planning and scheduling at the same time, since the addition of a bar to the chart represents an operation to be carried out within the certain sequence and at the fixed time. Such a process does not allow the programmer to focus his concentration on planning the operations in a logical and correct sequence to the exclusion of his assessment of their likely duration.
- 2.2 The use of the bar chart is mainly restricted to control of the time element only of a project.
- 2.3 The bar chart can be used to portray major activities only, and only in a modestly sized programme can the required interdependences of one operation and another be adequately shown by such a method. However, because of the everincreasing size of present-day projects which can be broken down into thousands of significant operations, there is a need for methods of programming which can cope with the increased detail in a satisfactory way. Because of this disadvantage it may be concluded that much of the interdependence between activities must remain in the mind of the programmer and hence if his connection with the work is broken, the user of the bar chart is free to make his own interpretation.

				WEE	X X	WEEK NUMBER	Parking Complement of the Comp					
OPERALION	-	2	3	7	5	9	7	8	б	10	11	12
SITE CLEARANCE												
FENCING AND WALLS												
EARTH WORKS												
BITUMINOUS SURFACING		,										. 10
FOOT WAY PAUING AND KERBING			ganaga na daga pang magain mining sakada makaba kan mangai muni minin	·								
				\"\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	onarior to							
				ACTA .								

FIGURE 7.7 THE BAR OR GANTT CHART

- 2.4 In view of (2) and (3) above it will be appreciated that the bar chart does not facilitate the breakdown of time required to complete each separate activity which might be covered by one operation bar-line.
- 2.5 Many bar charts are constructed and progress is reported thereon without reference to the physical dimensions of the operations involved. Comparing the time expended on an operation with the time allowed for it, gives no indication of the physical progress being made.

All the above disadvantages contribute to a poor control of projects and other more precise means need to be used in order to overcome these disadvantages.

II The Critical Path Method and Programme Evaluation Research Task Method

The critical path technique had its origin from 1956 to 1958 in two parallel but different problems of planning and control in projects in the United States. In 1956, the E I du Pont de Nemours Company was constructing major chemical plants in America. These projects required that both time and cost be accurately estimated. of planning and controlling developed was originally called "Project Planning and Scheduling (PPS)" and covered the design, construction and maintenance work required for several large and complex jobs. requires realistic estimates of cost and time. It is this approach that has since been developed into the "Critical Path Method (CPM)", which has found increasing use in the construction industry. In 1958, development of PERT (Programme Evaluation Research Task" (as it was first called) was originated by the U.S. Navy which was concerned with the control of contracts of its "Polaris Missile" programme. contracts comprised research and development work as well as the manufacture of component parts not previously made. Hence, neither cost nor time could be accurately estimated, and completion time therefore had to be based upon probability. Contractors were asked to estimate their operational time requirements on three basic optimistic, pessimistic and most likely dates. These estimates were then mathematically assessed to determine the probable completion date for each contract.

It is therefore important to understand that the PERT system involves a "probability approach" to the problems of the planning and control of projects and are best suited to reporting on works in which major uncertainties exist. (10)

The basis of both PERT and CPM systems is the network model which is a diagrammatic representation of a programme or plan for a particular project (or part of project) which shows the correct sequence and relationship of activities and events required to achieve the end objective. (11) The network may consist of large numbers of arrows. All projects can be broken down into a series of constituent jobs or operations, each one of which is represented by one arrow in the The length and direction of the arrow is not significant but the flow of time for the job is assumed to take place from the The tail of the arrow therefore represents tail towards the arrow head. the commencement and the head the completion of the job. are arranged in such a way as to represent the appropriate sequence of operations within the project. This sequencing process can most readily be accompished by asking three questions of each operation:

- a. What operation immediately precedes this operation?
- b. What operation immediately follows this operation?
- c. What operation can be carried out concurrently with this operation?

Operations that can be carried out either immediately before or after the operation in question are placed in series with the operation. Those that can be carried out concurrently with it are placed in parallel. In some cases it is necessary to draw a "dummy" represented by a dashed arrow. It is used to indicate dependency and in order to

J M ANTILL & R W WOODHEAD. "Critical Path Methods in Construction Practice" second edition. (New York 7 John Wiley & Sons. 1970)p.2.

P BARTON. "The Critical Path Method" The Commercial Accountant vol. XVIII No. 1 January 1967. pp.16-18.

J J O'BRIEN. op.cit., pp.5-8.

J M ANTILL & R W WOODHEAD op.cit., p.11.

that there is only may out

keep node numbers unique for identification purposes. A dummy does not represent the use of time or resource. The nodes of the diagram - where the head of one or more arrows joins to the tail of one or more arrows - correspond to the events or milestones of the project. It is essential in the diagram that every arrow represents a complete operation - one that is required to be fully completed before the ensuing serial operation can be started. (12)

Having constructed the network model and checked it to ensure its accuracy, durations can be assigned to each operation, and marked against the relevant arrows in the diagram. (13)

PERT versus CPM for construction work

A comparison between PERT and CPM has been carried out by O'BRIEN; he concluded that the differences can be illustrated as the following. (14)

No.	Consideration	PERT	СРМ	Different	Similar
1	Based on logic network	Yes	Yes	1.1.	X
2	Emphasis	Event & Activity	Activity		X
3	Time estimate, project time	Yes	Yes		X
4	Method of estimating time	One or Three	One		Х
5	Probability	Yes	No	Х	
6	Schedule event time	Yes	Sometimes		X
7	Total float "slack"	Yes	Yes		X
8	Free float	No	No		X
9	Negative float	Yes	Sometimes		X
	Used for planning new work	Yes	Yes		Х
	Used to monitor existing work	Yes	Yes		Х

R PILCHER. "Budgetary and Cost Control for Civil Engineering Construction Allied to Modern Methods of Programming" op.cit., pp. 24-26

The construction of arrow diagrams is discussed in detail in the following references. J J MODER & C R PHILIPS, "Project Management with CPM and PERT" (New York, Reinhold Publishing Corporation 1964.)

K J LOCKYER "An Introduction to Critical Path Analysis" (London, Sir Isaac Pitman & Sons Ltd., 1967)

¹⁴ J J O'BRIEN op.cit., pp.104-107

From the tabled comparison, it is clear that there is only one outright difference between the two methods; this is the "Probability" of meeting a scheduled date for an event and/or activity. Indeed this should be the case as the final activity duration in the PERT system is based on three initial estimates of the activity duration — the optimistic, the most likely, and the pesimistic time — and is based on only single-time estimates in CPM. PILCHER, in his thesis, examines the use of PERT and CPM and recommends the use of CPM in the construction industry. He states:

"On balance there is certainly a very much stronger case for adopting the single-time estimate in construction work" (15)

The use of CPM might be easier to use in the Highways Department as it usually carries out relatively small projects. The estimator will in this case be asked to estimate a single time for each activity, and he should allow a margin of time for each activity to cover bad weather, and other uncontrollable stoppage, according to his experience and the surrounding circumstances.

A comprehensive study of the advantages and disadvantages of use of CPM as a tool for planning and control in the construction industry has been carried out by PILCHER, the main advantages can be summarised as follows:

- 1. CPM offers a systematic approach to the determination of the time/cost optimised duration a duration which is unique for the data supplied, and which is unlikely to be calculated with any certainty unless some form of systematic approach is used. This advantage may be extended to more general form, as CPM encourages a logical discipline in the overall process of planning, scheduling and control of projects.
- 2. CPM allows the practice of management by exception. It concentrates attention onto the critical activities whose timely and successful completion are necessary to the achievement of the overall programme target.

R PILCHER, "Budgetary and Cost Control for Civil Engineering Construction Allied to Modern Methods of Programming" op.cit., pp.49-55

- 3. Activities which are not critical have a quantitative measure of their float or leeway assigned to them.

 This enables some activities to be completed more slowly than scheduled, without detriment to the programme as a whole. It also simplifies the management ask of assessing the effect of variations on the planned timetable. Float can also be used to smooth resources requirements by moving activities within the boundaries set up by the float calculation.
- 4. It facilitates the most economic scheduling for many different project durations and enables time and cost considerations to be given to the many different aspects of each job e.g. method, equipment, material, working hours, gang size.
- 5. CPM allows the engineer to make a comprehensive study of crash procedures at any point in the programme in order to anticipate likely bottlenecks which may arise if the project is to be speeded up. The CPM method throws up future bottlenecks easily enough to enable corrective action to be taken.
- of CPM since it does pinpoint the responsibilities of individuals for carrying out certain jobs within the framework of a project. By breaking down the project into suitable jobs, or groups of jobs, the allocation of responsibility can readily be made and precisely communicated.

It is clear, therefore, from these advantages, that as a management tool for planning and control, CPM has tremendous potential and its use is more advantageous than the work schedule bar chart.

The main disadvantages of CPM in use in the construction industry as summarised from the PILCHER study are the following: (16)

- 1. It is frequently not realised that CPM is an aid to making decisions rather than a decision taken. Human judgment is still required. The results obtained from the use of the technique are no more significant than the input. A correct schedule cannot be produced by incorrect use of the tool, neither can a project be realistically condensed into a shorter overall duration merely by chopping durations without due consideration of the pertinent facts.
- 2. There is a marked reluctance to move from the static, traditional methods of planning and control to the dynamic methods required with CPM. Fear of exposure, unsuitability and unfamiliarity are all human reasons for such reluctance.
- 3. CPM is not fully effective unless it is integrated with other existing management systems. It must be used in such a way that effective use can be made of the input and output of other systems and methods.
- 4. It is difficult to establish the appropriate scale of detail necessary to adequate control. Too little detail gives rise to a simple network, but it offers scope for free decision by the operator even within the scope of a single activity.

 Too much detail produces a complicated network which cannot always be drawn with ease.
- 5. The use of the CPM method requires greater planning effort than the traditional methods, and therefore, the cost of such work must be greater.

The pressure from the use of a new dynamic method should be smoothed out with experience in use, and, to ensure full benefit from the use of CPM in the Highways Department, the programme of work prepared by the

¹⁶ Ibid pp.55-58

use of CPM should be integrated with budgeting and reporting systems. The size of projects in the Highways Department are relatively small and therefore it should be easy to establish the appropriate scale of details required for adequate control. The increase in planning and scheduling costs should not be significant as it is possible to plan and schedule the small size projects using CPM method manually. WOLKSTEIN explains this by stating:

"The Critical Path Method does not always require a computer and there are certain advantages to the manual use of CPM for scheduling a project that is not sizeable. The ground work for calculating and preparing the data necessary to plot the critical path of projects up to the computation stage is essentially the same whether computations are made manually or by computer. Furthermore, the judgment in either case depends on the skill and experience of persons preparing the data." (17)

The benefits of employing the CPM method in planning and scheduling projects should justify the extra costs.

The use of CPM and bar charts as a media for planning

The network diagram is the basis of CPM. "Events" in the diagram represented by convenient geometrical shapes, often circles, are joined by "activities" which are represented by arrows. The event at the beginning of an activity is known as a tail event "i", whilst that at the conclusion of an activity is known as a head event "j". estimated duration of each activity which should be determined by the engineers should be plotted on the network diagram. Figure 7.8 represents an example of a project network diagram. The total project time and the earliest and latest start time of each event can be calculated by using a simple matrix; the critical path can then be determined as the path which lies along those activities whose earliest and latest itme for their head and the tail events are the same, and whose total duration time is equal to the difference between the time of the first and last event in the diagram.

H W WOLKSTEIN "Accounting methods and control for the construction industry" (New Jersey, Prentice-Hall, inc. Englewood Cliffs. 1970)
p.118

The network diagram can be converted to a bar chart. Essentially this is done by using the head and tail number of each activity to show the logical link between activities. The activities should be listed in the chart in order of increasing head number. A normal bar chart for the project network diagram illustrated in Figure 7.8 is shown in Figure 7.9.

LOCKYER mentioned that the normal bar chart cannot easily deal with the case of inter-related activities in the project network diagram. He states:

"The Gantt chart does not easily show any inter-relationship between the activities. It is possible in small-scale work to "tie up" bars by dotted horizontal lines, but if more than a few activities are concerned then the chart becomes so muddled as to be useless." (18)

LOCKYER suggests that the use of a sequenced bar chart may overcome this limitation. In this chart the sequence of activities is collected into continuous bars to show the inter-relationship between activities. This type of chart should facilitate the determination of the project critical path and the boundaries of the non-critical sequences (19) - Figure 7.10 represents this type of chart for the same example illustrated in Figure 7.8.

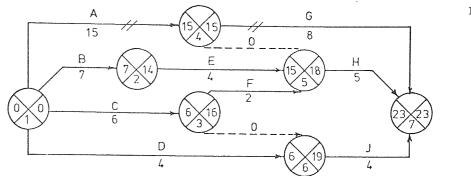
The planning and scheduling of resources, in addition to time and time based on cost, have been considered in the second generation of network analysis using CPM. Decisions concerned with resource allocation should be made both at the planning and at the scheduling stages of a project. In the initial planning some resources may have to be considered and decisions based on the known available resources of labour and plant may have to be taken; later, when the plan is scheduled, it may become clear that limitations on resources do not allow the parallel scheduling of certain activities.

¹⁸ K G LOCKYER op.cit., p.78

¹⁹ Ibid. p.81

See Appendix 9 for examples concerning the determination of the type and number of plant required to carry out the improvement work.

²¹ R PILCHER "Budgeting and cost control for civil engineering construction allied to moder methods of programming" op.cit., pp.46-47



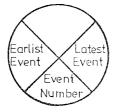


FIGURE 7.8 A PROJECT NETWORK DIAGRAM

Critical Path

Act	i	i	Dur	FS	NUMBER OF WEEKS OR DAYS
		,	 		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 24
В	1	2	7	0	
С	1	3	6	0	<u> </u>
А	1	4	15	0	(a) (b)
Е	2	5	4,	7	② ⑤
F	3	5	2	6	(3) (5)
Dummj	/ 4	5	0	15	(a) (5)
D	1	6	4	0	<u>6</u>
Dumtny	. 3	6	0	6	3 ₁ 6
G	4	7	8	15	\$ 0
Н	5	7	5	15	© Ø
J	6	7	4	6	

Free Float

EXXXXX Indpendent Float

----- The Critical Path

FIGURE 7-9 NORMAL GANTT OR BAR CHART AT EARLY START FOR THE ABOVE NETWORK

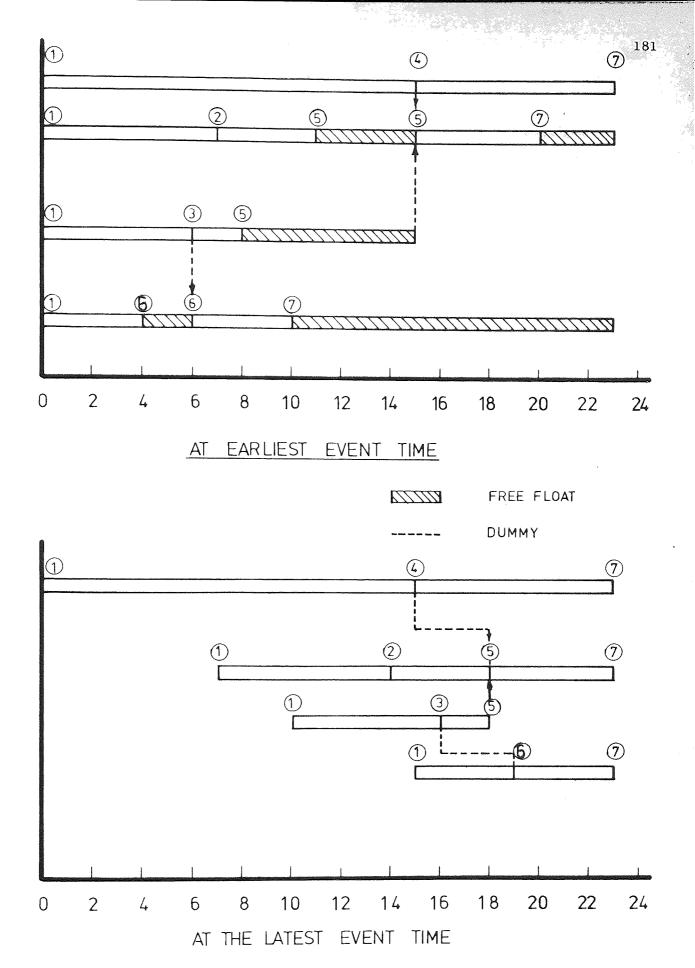


FIGURE 7: 10THE SEQUENCED BAR CHART AT EARLIEST AND LATEST EVENT START FOR THE SAME NETWORK

The sequenced bar chart should help in scheduling and allocating This can be achieved by preparing the sequenced bar resources. chart for the earliest and latest start for each event. scheduling procedures should ensure that when a continuous operation activity is started it will be worked without interruption until finished, and an intermittent operation activity can proceed piecemeal in isolated sections at irregular periods of time. This procedure becomes helpful when choosing the most suitable time to execute the activity. A compromise between these two schedules "earliest and latest start" can then be carried out to ensure that constant resources are used over the whole project duration. (22) The development of such a compromise schedule is known as "resource levelling".

The use of CPM and the sequenced bar chart as a media for planning and scheduling should be limited to the improvement operations in the Highways Department as the nature of maintenance work differs from the construction work, and its programming requires different procedures. The use of CPM and the sequenced bar chart in programming and scheduling improvement operations should ensure full utilisation of plant and labour on sites, and should help in controlling the operational costs through the use of the operational budget previously described.

The link between the operational budget and the programme of work

The improvement operations have been classified under the cost units main code 2. The operational budget which should be prepared through the preparation of materials, labour, and plant schedules necessitates the distribution of the work on a weekly basis according to the programme of work which - as a result of the previous discussion should be prepared through the use of CPM and the sequenced bar chart. The improvement operation may consist of a number of activities which may start and finish at the same time or different times, especially if the operation is a part of a large project. The network activities should be distributed over the appropriate operation "cost unit" and this should then be entered into the operations budget schedules.

A comprehensive example of scheduling procedures is illustrated in Appendix 8.

These procedures can be carried out by allocating each activity to the appropriate operation by using the following table:

ad No:		Operation No: Project						
			Activities					
Schedule No	Descript- ion	i-j	Descript- Duration Start time					
		eradokada manyapiyo opa kanakada katingga						
	Cost Uni Operation	Cost Unit Operation Schedule Descript-	Cost Unit Operation Schedule Descript- i-j	Cost Unit Operation A Schedule Descript- i-j Descript-	Cost Unit Operation Activities Schedule Descript- i-j Descript- Duration	Cost Unit Operation Activities Schedule Descript- i-j Descript- Duration Start		

The distribution of materials, labour, and plant in the appropriate operational budget schedules should be prepared according to the resources required to execute the weekly programmed activities. (23)

The Divisional improvement work programme

The annual programme of the divisional improvement work should cover all improvement projects waiting attention in the following year after being approved by the budget committee and the County Council. The divisional programme of work should be based on the improvement work operation budgets. A list of projects should then be arranged in order of preference as shown in Figure 7.11.

See Appendix 10 for an example concerning the preparation of the improvement cost unit budget.

T			
	Suggested Starting	Date	
		Duration	
es	nt	No	
Required Resources	Plant	Description	
Requ	Road men	Duration	
	Ro	No	
	Project duration		
Estimated	Total Cost	લ	
Operation	Budge t No		
	Road No		
	Project No		

Figure 7.11 The divisional improvement work programme list of projects.

The number of construction gangs in the divisions, and the number of workers required for each project should be taken into consideration when preparing the division's programme of work. It is recommended that a bar chart should be prepared for programming and allocating the work to the construction gangs in the divisions. The gang numbers should be listed vertically on the left-hand side of the chart, replacing the operations as in Figure 7.7. The planned projects, which should be executed by the gang, should be plotted in the horizontal bar against each gang according to their starting time.

ANTILL and WOODHEAD mentioned that a combined network which accommodates the project networks as one activity can be prepared to programme the annual work to be carried out during the following year. They suggested that the urgent work should be accommodated first, and the rest of the projects may be fitted into the network in the available floats. (24)

This suggestion seems to be acceptable, but it necessitates that improvement projects should be programmed for the whole Highways Department in order to ensure continuity of labour and plant utilisation over the whole department. The use of such a suggestion for an individual division may prove to be unnecessary as a result of the limited number of construction gangs in each division; this should limit the number of improvement projects which may be executed simultaneously.

The planning and programming of maintenance work

The maintenance operations usually cover small time durations, therefore CPM method is not suitable for planning and programming the annual maintenance work. The Marshall report cited that:

"network programming is likely to be too complex an approach for most maintenance operations. We believe that simple charts could provide a valuable aid to the efficient planning and programming of maintenance."(25)

J M ANTILL & R W WOODHEAD, op.cit., pp.201-205.

Report of the Committee on Highway Maintenance. op.cit., p.158.

The maintenance work which should be carried out by the divisional maintenance gangs should be split into routine maintenance work covering all routine maintenance operations, major maintenance work covering resurfacing and heavy patching operations and emergency work. It may be useful to have a specialised gang or gangs to carry out the resurface programme for the whole country. This gang to be under the direct control of the surfacing engineer.

This classification should facilitate the procedures of planning and programming of maintenance operations. It is suggested that these procedures should be as follows: (26)

1. Routine maintenance work planning and programming

The planning and programming of the divisional maintenance work should operate on a flexible cycle basis, with a target of visiting each parish within the division borders in a predetermined order with a minimum number of visits during the year. The cycle duration should be three months, this to provide at least one visit to each parish during each season. The number of times that a parish can be visited during each cycle should be determined by the divisional maintenance engineer, who should apportion the routine maintenance areas to individual gangs so as to provide equality of work load throughout the division, bearing in mind that some areas require more maintenance than others. The number of days allotted to work for each parish should be prepared by the area maintenance supervisor according to his experience. A programme of work for each maintenance gang should be prepared in the following manner:

The routine maintenance gang programme of work

A simple bar chart representing the allotted days for each parish determined by the area supervisor during the programme period should be prepared. A two week float should be included in the programme in order to permit time for emergencies and bad weather; in such a case the programme of work will be delayed by the number of days spent in the emergency work. The change of programme should clearly appear in

These procedures are proposed as a result of studying and observing the existing planning and programming procedures taking place in the Highways Departments divisions visited during the survey.

the chart. Figure 7.12 represents the suggested chart. In this chart the gang has eleven parishes to visit during the original ten week cycle. As it is shown in the chart, the work was carried out smoothly till the third day of the fifth week during which the gang was visiting parish (E). On the fourth day the gang went to carry out emergency work for a two day "Period A". After that the gang returned to parish E to finish the programmed work. The result of this was that the programme duration was extended by two days and the planned visit to parish (F, G and H) delayed by two days. During week nine there was bad weather for one day "Period B" during which the gang did not work and as a result their visit to parish (H) had to be extended by this day; accordingly their planned visit to parish (F) was delayed by another one day and the overall cycle extended by three days (Period A and B). As a result it is clear from the chart that by the beginning of week ten, the gang have to go to parish (H) for another one day instead of working in parish (I).

The gang chart in this manner permits flexibility of programming by using the two weeks float. The programming of the next cycle visit should begin immediately after finishing work in parish (J) and it is not necessary to repeat the same programme in the second cycle, as this may change as a result of seasonal demand and public needs.

The work to be executed during the gangs' visits to parishes should be determined, say one week before the scheduled visit to the parish. The maintenance supervisor should inspect parish(es) and prepare an "Inspection Report" - Figure 7.13. He should ensure that the work in the parish(es) is sufficient to occupy at least one working day in order to formulate the basis of the weekly programme according to the priorities of work, the work held in the parish previously, the work notified from parish councils, and other work instructed by the maintenance engineer. The maintenance supervisor should then prepare "the weekly programme of work" - Figure 7.14 - for each maintenance gang, (original and four copies), and distribut these in the following manner:

 The orginal is to be discussed and given to the ganger to carry out the programmed work.

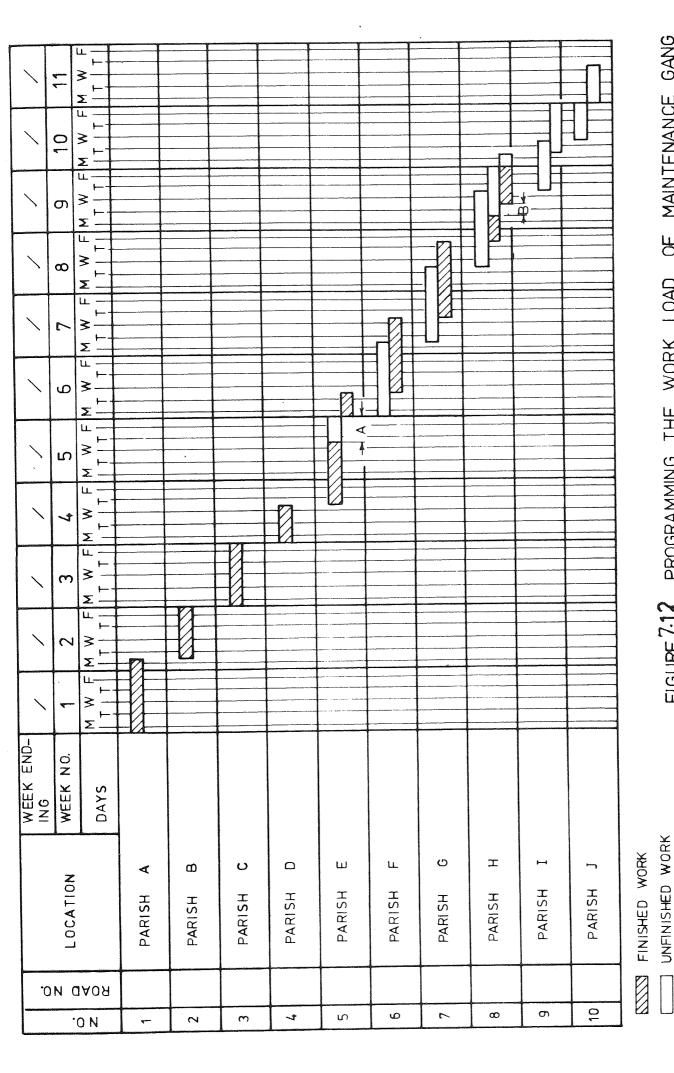


FIGURE 7.12 PROGRAMMING THE WORK LOAD OF MAINTENANCE GANG

WITH TWO WEEKS FLOA

DELAY FOR EMERGANCY DELAY FOR BAD WEATHER

d w

Inspection Report No. Week Commencing: Division No: Location of Parish: No. of days: Ganger Name: No. of days Supervisor Name: Materials Labour Plant Parish and Cost unit Measure-Priorities Suggested work road no. code no. ment No.of No.of No.of Quant. Type Descrip. Days Men Hours Transferred to gang The operation Code No. according to programme No. ____ the cost unit code 2. Priority 1: Work needing immediate attention Priority 2: Other work needing attention during period of visit Priority 3: Work not needing attention before next visit. Figure 7.13 The inspection report for routine maintenance

				 1	ξξ
			Instructions		
			Plant	No.of days	
		me:	FIE	Туре	
		Ganger Name:	our	No.of hours	
			Labour	No.of men	
Work No:			ials	Quant.	
gramme of		18:	Materials	Descrip.	
Gang Weekly Programme of Work No:		Week commencing:		Measurement	
der der Peter der der der der der der der der der d		•		Suggested work	
:0			Friority		
	Inspection Report No:	n No:	Cost Unit	Code No.	
	Inspect	Division No:		and/or Road No.	

Figure 7.14 Gang Weekly Programme of Work

- 2. The first copy should be sent to the divisional budgetary control office who should prepare the operational budget schedules for all operations involved in the programme of work.
- 3. The second copy should be sent to the work study office to compare it with the gang's weekly work sheet which should be prepared by the ganger showing the actual work executed by the gang during the previous week.
- 4. The third copy should be sent to the divisional maintenance engineer.
- 5. The fourth and last copy should be kept with the maintenance supervisor.

2. The major maintenance work programme of work

The major maintenance operations have a longer duration than the routine maintenance operations. This type of operation requires a special type of plant which is not normally used in executing the routine maintenance operations. If the suggestion of having a special resurfacing gang for the whole county is adopted then each division should present to the surfacing engineer its annual resurfacing work schedule for the next year, approved by the budget committee and the The surfacing engineer should then programme the county council. resurfacing gang visits to the different sites according to the estimated capacity of the resurfacing gang. It is important in planning each operation, to ensure that the appropriate quantities of mixed materials are delivered to sites in the appropriate time, because any delays in delivering materials means that the gang and plant on site will be out of work during the delay period, this can mean extra operating costs and lower gang performance which may extend the duration of the operation and disturb the whole programme of work.

The same bar chart - Figure 7.12 - should be used for programming and scheduling the work for the resurfacing gang. The programme of work should be sent to the ganger, with copies to the divisional maintenance engineer, divisional contract office (in order to prepare the

operational budget schedules) and the work study office. A copy of the programme of work should be kept in the surfacing engineer's office.

3. The emergency work

Emergency work cannot be anticipated and therefore cannot be planned. The preparation of an operational budget for emergency work carried out by "the fire-brigade gang" will be a difficult task, and therefore it is suggested that the actual cost of this type of operation should be compared against similar work carried out before in normal circumstances.

CHAPTER 8

THE COST CENTRES BUDGET IN THE HIGHWAYS DEPARTMENT

The cost centres in the Highways Department have been divided into, plant cost centres, administration cost centres, and services cost centres. This chapter will cover the suggested budgeting system which should be employed in these cost centres, and will also deal with the purchases budget of the Highways Department. Therefore, this chapter will be divided into the following sections:

Section One: The plant cost centre budget.

Section Two: The service cost centres budget.

Section Three: The administration cost centre budget.

Section Four: The purchases budget.

SECTION ONE

THE PLANT COST CENTRE BUDGET

The plant cost centres have been classified under plant cost centre code 3 - Appendix 2. A budget should be prepared for each of these cost centres in order to estimate the total cost of each cost centre, and accordingly their absorption rate per day, or per hour. The plant cost centre budget should also be used for controlling the cost centre costs.

The plant cost centre budget should cover the expected annual cost of the cost centre; this to include both capital and running costs.

1. The plant capital cost

The plant annual capital costs consists of annual depreciation and interest on capital.

Depreciation concepts

PARK, mentioned that the various definitions of depreciation can be placed in one of four categories. $^{(1)}$

- 1. Impaired serviceableness the engineering concept; this implies a loss in utility or efficiency which results from either physical causes - wear and tear - or functional causes attributed to obsolescence.
- Decrease in value; this concept requires that the asset value be computed at different points in time, without defining what is meant by value, or what caused the decline - market value or value to the owner.

W R PARK 'Cost engineering analysis'. (London, John Wiley and Sons 1973). p. 95.

- 3. Difference in value the appraisal concept; this refers to the difference between the present value of existing and the present value of a hypothetical new, but similar, property.

 Depreciation in this case related to the asset's physical condition.
- 4. Amortized cost; depreciation according to this concept is the difference between the original cost and the current book value; the asset's original cost is written off over its economic life.

The objective of calculating plant depreciation in the Highways Department is to charge the cost unit with its share of plant costs; this can be achieved through the allocation of the plants' initial costs to the cost units, according to a predetermined rate which should include the plant capital cost. It is recommended that the amortized cost concept should be used for determining the annual depreciation of the plant cost centres.

The methods of calculating the annual depreciation

There exist a number of commonly accepted methods for calculating the annual depreciation charges which are summarized as follows:

- (1) The straight-line method of depreciation; this method assumes that the value of an asset decreases at a constant rate, and therefore the initial value of plant less anticipated salvage value should be divided over its economic life in order to find the annual depreciation.
- (2) The declining-balance method of depreciation; this method also assumes that the value of an item of plant decreases, but at a faster rate in the early portion of its economic life than in the latter portion. The annual depreciation in this case can be determined by multiplying the value of the item of plant at the beginning of each year by a fixed, predetermined rate. This rate of depreciation is usually bigger than the rate under the straight-line method and does not depreciate the initial plant value except when calculating the appropriate rate of depreciation for each item of plant.

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(3) The sums-of-the-years digits method of depreciation; this is the same as the declining balance method. It assumes that the value of an item of plant decreases at a decreasing rate. The annual depreciation can be calculated by adding together the digits, representing each year in the economic life of the item of plant, then an appropriate proportion of this total is taken for each year.

- (4) The sinking-fund method of depreciation, this assumes that a constant amount of the plant initial cost will be reinvested at some compound interest rate, so that the total principal and interest will accumulate at the end of the plant's economic life to an amount equal to the plant's original cost.
- (5) The service output method the production method; this assumes that depreciation occurs on the basis of services performed without regard to the duration of the plant's life, therefore, depreciation should be calculated according to the actual service performance.
- (6) A combination of different methods; this method uses the declining balance method over the first half of the plant's life, switching to the straight-line method for the last half. It offers a rapid write-off initially, then later stabilizes the deduction of depreciation. The half-way point can be determined as the point at which the straight-line deduction exceeds the amount deductible by continuing the declining balance rate.

It may be argued that non profit-making enterprises should not record depreciation as do profit-oriented enterprises in which depreciation accounting is essential; ANTHONY and WELSCH mention that the calculation of depreciation should be accounted for in profit oriented

For further reading on depreciation methods see:
G A LEE 'Modern financial accounting' (London, Thomas Nelson and Sons Ltd. 1973). pp. 102-132.
H G THUSEN, W J FABRYCKY & G J THUESEN. 'Engineering Economy' Fourth Ed. (New Jersey, Prentice-Hall, Inc. Englewood Cliffs 1971) pp. 258-266.

R A ANTHONY & G A WELSCH 'Fundamental of management accounting' (Illinois, Richard D Irwin, Inc., Homewood 1974) pp. 107-109.

enterprises, as it cannot be said that the enterprise has made a profit unless its revenue exceeds all its costs, including the cost of fixed assets in use. The non profit-making enterprises do not have the same need to match depreciation expenses with revenue because they draw funds for fixed assets from special appropriations made for that purpose, rather than from revenue. On the other hand, a number of arguments for charging depreciation as an expense in the non profit-making enterprises have been made by ELLENBERGER and HENDRIKSEN. ELLENBERGER, in his article 'A look at depreciation accounting in non profit organisation' states:

"A good argument for charging depreciation as an expense is the effect it has on bases for rate determination. If depreciation is charged, total operating expenses are - of course - raised by the amount of the depreciation.... depreciation increases the base rate and, in turn, increases the total amount of periodic revenue realized". (4)

HENDRIKSEN mentioned that the total costs of services, in non profitmaking enterprises which include depreciation are useful in evaluating the cost of services provided for comparative study purposes. (5)

As a result of these arguments, it seems that the Highways Department - which is a non profit organisation - should include depreciation in the cost of the work executed by its direct labour force for the following reasons:

1. The Highways Department works as an agent for the Department of the Environment. It may carry out the maintenance and improvement work of the trunk roads and motorways, and charges the Department of the Environment with the cost of this work. It may also carry out work for outside parties and charge them with the cost of the work in these cases, the Highways Department is charging fees to outside parties for a part of its

J O ELLENBERGER 'A look at depreciation accounting in non profit organisation'. NAA Bulletin, Vol. XLII, Sec 1 January 1961, p. 57.

E S HENDRIKSEN 'Accounting theory'. (Illinois, Richard D Irwin, Inc, Homewood 1970) p. 418.

services, therefore, it is necessary to include depreciation in the fees charged.

- The Highways Department may compete against contractors to carry out a particular operation; in this case the Highways Department should include the 'true' cost of the operation.
 This true cost should include depreciation as a part of the cost elements.
- 3. The total cost of plant is required for decision-making concerning the determination of the size of the plant fleet, buying versus hiring decision.

The cost of capital

There are a number of sources from which the capital expenditure may be financed for the purchase of plant in local authorities. These sources (7) are:

1. Revenue: A local authority may consider that, as a general policy, it will charge to revenue the maximum amount that it possibly can to save paying heavy interest charges, and thus the total cost of the capital is reduced. It might be assumed that the financings from revenue are so self-evident that local authorities ought to meet most, if not all, of their capital expenditures in this way. In fact this is not what happens and the subject is indeed extremely controversial. The arguments against financing capital expenditure from revenue are, that it would impose too great an immediate burden on present ratepayers; the assets which are created by the expenditure are created for the benefit of future as well as present ratepayers and, therefore, future ratepayers ought to bear some

Working Parties on the organisation of highways and maintenance.

"The principles of cost comparison between the use of direct labour organisation and outside contractors for highway maintenance".

Unpublished report No. CO20. UO13. p. 4.

N P HEPWORTH, 'The finance of Local Government' Second edition (London, George Allen Unwin Ltd 1971) pp.126-162.

of the cost. On the other hand the effect of inflation, which reduces the value of money, means that if borrowing is reported to, then the debt is repaid in depreciated pounds and, therefore, the real cost to the ratepayer is less than it would have been had the expenditure been financed from revenue. In addition, for trading services and general rate or county funds - services which are not grant-aided - no consent of a government department to a scheme is required where it is proposed to meet the cost out of the revenue, whereas such consent is required if the scheme is to be financed by borrowing.

- 2. Borrowing: Once a local authority has decided to borrow, to meet the cost of capital expenditure required to finance a scheme, it may borrow from special funds set up by the local authority to meet the cost of the capital expenditure or it may, either borrow the money from a third party or borrow it internally from funds accumulated for such purposes as employees' superannuation, housing repairs etc. The balance available in these funds can be invested internally in financing the capital expenditure, and, the rate of interest allowed for on the internal fund, is usually the same as the rate which would have been allowed on the equivalent loan from a third party.
- 3. Leasing: An alternative method of financing capital expenditure is to lease the required items from a financing company. In this case the local authority will not need to obtain a loan sanction from the government; the annual payment will be fixed for the period of leasing, and the local authority can claim a reduction in the annual payment due to the fact that the financing company can claim a tax allowance over its transaction with the local authority. On the other hand, the local authority should recognise that ownership of leased equipment does not pass to it, and the leasing periods are generally shorter than the equivalent borrowing periods.

The County Treasurer is concerned with the overall management and finance of the local authority's debts; he is not concerned with raising loans to finance individual projects or the needs of particular departments. The Highways Department should, therefore, get the capital for purchasing new items of plant from one of the above mentioned sources of capital expenditure; this means that if the capital expenditure is financed

from revenue, this capital should be free of interest, on the other hand, if it is from other sources, it should bear interest.

In fact, since the allocation of the county capital expenditure to the different departments is the responsibility of the County Treasurer, it is suggested that all capital expenditure allocated to the different departments of the County Council should be charged with the same interest whatever the source of funds. In doing so, the rate of interest over the borrowed capital should be adjusted; this should reduce the rate of interest over the whole of the capital expenditure used in the County Council and provide a fair method of allocating the cost of capital. (8)

The calculation of the plant annual cost

The plant annual cost should consist of the plant annual depreciation and the annual interest on capital. The proper depreciation method, which should be used in calculating the annual depreciation, should take into consideration the effect of the cost of capital on the plant annual cost, (9) The selecting of the appropriate method which should be used in the Highways Department will be discussed through the following example:

The capital cost of an item of plant, which costs £5000 with £1000 salvage value at the end of five years and an adjusted interest rate of 8%, has been calculated by using the straight line method, the declining

The geometric mean should be used in calculating the adjusted rate of interest and not the arithmetic mean, as the calculation is dealing with raios. See B C BROOKES & W F L DICK "Introduction to statistical methods" (London, Heinemann, 1965) pp. 45-49.

In practice in the Highways Departments, the usual approach of calculating depreciation is to depreciate 25% of the purchase price of medium life equipment in the first year, with 10% decreasing annually thereafter; whilst for shorter life equipment, a "straight line" depreciation factor is often employed. See Appendix One.

Also see, E L COLE. "Plant management purchasing, replacement and disposal". Seminar proceedings in management systems in highways offices 11. (London, PTRC Publication Co. Ltd. 1973) p. G8.3.

balance method, and the sum-of-the-years digit method. A comparison between the annual total costs, and the total costs of each method - Table 8.1 - shows the following:-

- 1. The sum -of-the-years digits method has the lowest total cost of £5146; the declining balance method a cost of £5161, and the straight line method a cost of £5376.

 The reason for these differences is that the sum-of-the-years digits depreciates a greater amount of the plant cost in the early years, and therefore the interest on capital is small (£1146), compared with £1162 for the declining balance method, and £1376 for the straight line method.
- 2. The total annual capital cost has been decreased by using each of these methods as a result of the fluctuation in the amount of the annual depreciation calculated by the use of each of these methods.

It may be concluded that the sum_of_the_years digits method of depreciation is the method which should be used; it has the lowest overall cost of £5146, over the five years; but the annual capital cost in this case will fluctuate from one year to another and this will affect the plant cost centre daily rate which should be charged to the cost units. The use of any other method will have the same effect but with differences in the degree and direction of the fluctuations, and the effect of these fluctuations on the cost centre charged rate will be most marked when a new item of plant is purchased and included in the plant centre. The fluctuations of the annual capital cost, and its effect, may mislead the plant engineer and affect his ability to make decisions.

In order to overcome the problems which may arise as a result of the fluctuations in the annual capital cost of plant, a new method which ensures a constant annual capital cost is needed. The "annual cost" method of appraisal provides a uniform series that will exactly recover the plant capital cost. This uniform series covers depreciation and the interest on capital. The use of this method necessitates the use of a capital recovery factor (CRF) table - Appendix 7. The annual cost of an

) to D	1082	1062	1082	1082	1082 .		5410
G)	Total Cost (1)	10	10	- 10		10		<u> </u>
T TELEVIE	Amnal Dep.	682	737	962	860	728		4002
ANTATAL COST LETHOD	Interest on Capital i = 8%	. 400	345	286	222	154		1408
	Total cost at start of period	5000	4318	3581	2786	1926	866	
RETHOD	Total Cost	1733	1360	1008	229	368		5146
SUM-OF-THE YEAR DIGIT LETHOD	the Annual Dep. N-t+1 N(N-1)/2 x(P-F)	1333	1067	800	533	267		4000
THE YEA	Interest Annal on Dep. Capital $N-t+1$ $i=8/i$ $N(N-1)/$ $x(P-P)$	400	293	208	144	101		1146
SUM-OF-	Total Cost at start of of period	5000	3667	2600	1800	1267	1000	
HOD	Total	1775	1287	.933	929	490		5161
BALANCE METHOD	Annual Dep. R=27.5% ExB.t-1	1375	166	723	524	380	*	3999
TING BALL	Interest Annual Dop. CapitalE-27.5% i = 8% BMP1	400	290	210	152	110		1162
DECLINING	Total Ecost at start of	5000	3625	2628	1905	1381	1001	
CO.	Total Cost	1200	1136	1072	1024	944		5376
INE MEYTH	Annusı Dep. P - F	008	900	800	. 800	800		4000
STRAIGHT LINE MEYHOD	Interest on Capital	400	336	272	224	144		1376
STI	Total cost at start (5000	4200	3400	2800	1800	1000	
	PERIOD	_	2	m	4	ľV	9	Total.

P = The original cost of plant; F = Estimated salvage value; N = Estimated economic life; i = Rate of interest on capital

R = Adjusted rate of depreciation

⁽¹⁾ Total annual cost = $(P-F)^{\frac{1}{2}}$ (C.R.Factor)^R + Fi

item of plant can be calculated by using the following formula. (10)

 $R = (P - L) (CRF)^{t} + L i$

where

R = The annual cost

P = The plant initial cost

L = The salvage value at the end of the economic life

i = The adjusted rate of interest

t = The economic life of the plant

CRF = The capital recovery factor

By using this formula, the annual cost of the item of plant in the previous example should be

$$(5000 - 1000)$$
 $(0.2505) + 1000 \times 0.08 = £1082$

This means that the cost of capital over each of the five years - the estimated economic life - should be £1082, and the total cost is £5410 - Table 8.1.

A comparison between the results of the "annual cost" method, and the straight line method, (the other two methods should not be used as a result of their sharp fluctuations which affect the plant cost centres charged daily rates), shows that the "annual cost" method will cost just £34 (5410 - £5376) more than the straight line method. On the other hand, the annual capital cost remains constant when using the "annual cost" method and fluctuates from one year to another when using the straight line method.

From the above-mentioned discussion, it is suggested that the annual capital cost of plant in the Highways Department should be calculated according to this "annual cost" method, which covers the plant annual depreciation and the interest on the remaining balance at the beginning of each year.

G A TAYLOR "Managerial and engineering economy" (London, D van Vostrand Co. Inc. 1964) p. 26.

The annual costs calculation should be reviewed when the adjusted rate of interest on capital is changed, to ensure that the plant cost centre is charged with the actual rate of interest for each period.

2. The plant running cost

The annual running cost of each plant cost centre consists of: material, mobile plant expenses, repairs and maintenance in and outside the central repair depot, and the plant annual fixed costs. These types of cost should be determined for each cost centre through the "plant running cost estimate" - Figure 8.1 -. This form should be prepared by the central repair depot, control office, purchase office, and superintendent, and should be approved by the plant engineer.

The central repair depot superintendent should enter the materials consumption, the man hours required to carry out the maintenance and repairs work, and the estimated cost of those maintenance and repair works which the central repair depot cannot achieve during the year, and therefore should be carried out by contractors, in the plant cost centre plant running cost estimate form.

The purchasing office should enter the materials prices according to the latest annual tender.

The control office should complete the form by entering: the last year's actual costs and quantities, the planned load of work which should be carried out by the cost centre plant according to the cost centre programme of work, the rate per hour for the central repair depot fitters, the overheads, and the estimated expenses costs. The office should also carry out all the necessary calculations.

The plant cost centre budget

The plant cost centre estimated costs should be the basis for calculating the estimated rate per day of each plant cost centre, which should be charged to the cost units, when an item of cost centre plant is used in carrying out the work. There should be two rates, the first is the ordinary rate which should be charged to the cost unit against working days, and the second is for idle hours on sites; the physical idleness of plant on site will not affect those costs that are variable

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111	Salvada Guard alvera (Madrio	581702					535	Tyre repairs					
	<u></u>	-			- 1			Total					
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	Total						Furcha Cost A	Purchasing Office			Total	Total Cost of £	
							Centre	al Repair Depot.	***************************************	Plen	t Engineer	Plant Engineer	

Fig. 8,1 PLANT RUNNING COST ESTIMATE

since these costs will not be incurred. (11)
be calculated as follows:-

- 1. The ordinary rate per/day The plant cost centre total estimated costs

 The plant cost centre programmed working days
- 2. The rate per/ hour during = $\frac{\text{The plant cost centre capital cost} + \text{fixed costs}}{\text{The estimated annual working hours}}$

The second rate - the rate per hour during idleness - should only be used to allocate the plant cost centre costs when the item of plant is idle as a result of uncontrollable reasons (eg. bad weather) and not as a result of inefficiency. The cost centre working days should represent the total number of programmed working days, for all units of plant included in the plant cost centre, which were the basis for the estimates of the plant running cost.

A flexible budget for each plant cost centre can be prepared by estimating the running costs for different levels of annual performance and determining the ordinary rate per day which should be charged to the cost units according to the appropriate level of performance.

An overall plant budget should be prepared to cover the estimated costs of all plant centres. Figure 8.2 represents the suggested budget which should include the following information:

- 1. The plant cost centre code number and description.
- 2. The total running costs estimates as in the "plant running costs estimates".
- 3. The capital cost as calculated by using the "annual cost" method.
- 4. The plant cost centre total costs which consists of the total running costs (2) and the capital cost (3).

D T DECOSTER 'Measurement of idle capacity variance'. The Accounting Review. April 1966. p. 299.

BUDGET
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- 5. The estimated number of working days, which is the basis of calculating the ordinary rate.
- 6. The ordinary rate per day, and the uncontrollable idleness rate per hour.
- 7. Last years actual running cost, capital cost, total cost, working days, and rates. (This may be used for comparison purposes).
- 8. Allocation of costs over the year on a quarterly basis. The estimated total working days during each quarter, and corresponding total cost, should be recorded in order to facilitate comparisons between the budgeted and the actual costs every three months; this enables the control office to revise the ordinary rate of all the plant cost centres every three months.

The plant cost centre programme of work

The plant cost centre programme of work should ensure complete utilization of the County Council plant according to the annual requirement, therefore, the central repair depot control office should receive a copy of the improvement and maintenance work programme of work with the item of plant description, the period for which it is needed on site and the location of the site. According to this information a 'plant utilization chart', Figure 8.3., should be prepared for each item of plant.

The 'plant utilization chart' should serve two purposes; the first is to help in determining the total annual working days for each item of plant, and the number of items required every day - this information should help in determining the economic size of the central repair depot plant as described in Chapter 6; the second one is to provide the control office with a scheduled programme of work for each plant cost centre.

The 'plant utilization chart' should accommodate the improvement operations requirements first, and then the maintenance operations requirements; this is because it may be difficult to determine the maintenance operations requirement in the early stages of preparing this chart. In this respect the central repair depot control office can propose delaying or advancing the execution of an operation in

order to minimize the number of hired plant days. This proposal should be presented to the budget committee through the plant engineer. The central repair depot control office should allocate the County Council's own plant to the operation first, and in doing so, the office should keep the cost of moving and erection of plant as low as possible; this means that an item of plant should be kept as long as possible in the divisional depot, and should not move to another division except if it is idle in this division and there is a need for it in this other division. All routine maintenance requirements and major plant repairs, should be scheduled to take place in the period during which there is no demand for the particular item of plant.

To demonstrate this, assume that the county own two excavators, that there are funds available to enable the central repair depot to include the purchase of a new excavator in the capital budget, and that this excavator will be delivered at the beginning of the second week of the financial year. Also assume that the excavators are needed in the first 14 weeks of the year for 10 operations throughout the Highways Department, six divisions, and the period during which excavators are required vary from seven day to seven weeks - five days a week.

The plant utilization chart for this example is shown in Figure 8.3. In this chart the following points have been considered.

- The County Councils own excavators have been allocated to the appropriate operations, then the rest of the requirements have been satisfied by hired excavators - operation 1 and 9 in the chart.
- 2. The new excavator has been allocated to a new operation starting on the same day as delivery; this to ensure continuity in the execution of the operation by the same excavator operator operation 4 and 6 in the chart.
- 3. An excavators has been hired for only one week as the County Councils excavators were involved with other operations operation 3 in the chart.

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Ö	1 2	3	7	5	9	2	8	മ	10	To the state of th	

- 4. A comparison between the cost of moving excavators from one division to another should guide the control office in determining which excavator is to be moved. At the end of the third week a comparison between the cost of moving excavator No 2 from division 1 and excavator No 3 from division 4, to division 2, should be carried out, and it is assumed that it is cheaper to send excavator No 2 from division 1 to division 2.
- 5. The chart ensured that all the County Council's own excavators are fully utilized excavator No 3 has been sent from division 4 to division 5 to carry out the work in operation 8.
- 6. The routine maintenance operations requirement, and the plant major repairs and routine maintenance can be carried out during the period in which the County Councils own excavators are out of work for example in week 10.
- 7. The 'plant utilization chart' enables the control office to determine the number of items of plant required every working day: ie. 1 excavator for 5 days, 2 excavators for 40 days etc., during the period of three months.
- 8. The 'plant utilization chart' shows any delays in executing the work. It shows a delay of 1 day during operation No.1.
- 9. It also shows the progress of the work as scheduled. The completion of the work is shown by the area in the top of each operational bar; it is shaded to 24.4.1974.

SECTION TWO

THE SERVICE COST CENTRES BUDGET

The service cost centres budget should cover those cost elements which are under the direct control of the service cost centre foreman, therefore, the spare parts required for repairing or maintaining plant should not be included in the service cost centre budget. This budget should enable the central repair depot control office to calculate the predetermined rate for allocation of the service cost centre overhead to the appropriate work carried out within that service cost centre. It should also aid the office in controlling the fitters performance and cost in the service cost centre. The same thing applies for the services cost centres in the central laboratory and divisions.

The determination of the service cost centre overheads rate

As mentioned in section one of Chapter four, the service cost centre overheads should ensure the allocation of the service cost centre materials costs and expenses, (but not including spare parts), therefore the service cost centre budget should include an estimate of quantities and cost of materials which are in use in the workshop. This can be determined according to last year's actual results, and the expected changes during the budget year - ie. changes in materials, prices or quantities. The established plant depreciation should be prepared for each item of plant in the service cost centre according to the 'annual cost' method described in section one. Electricity consumption should be determined according to last year's actual consumption and by taking into consideration any changes in the electricity tariff or changes in the daily working hours, a separate meter for each workshop should facilitate estimating. It is not difficult to determine these estimates on a quarterly basis, as it is assumed that the load of work in each of the service cost centres does not fluctuate during the year. The total estimates should be divided by four to determine the quarterly estimates needed for preparing the service cost centre budget on a quarterly basis; this should facilitate the revision of the overhead rate every three months to ensure complete absorption of the service cost centre costs.

This rate should be prepared according to the estimated normal working man hours in each workshop. The use of established plant working hours does not represent an accurate measure for calculating and allocating overheads to the plant cost centres as it does not represent an accurate measure of time spent on the repair or maintenance work required for each item of plant in each service cost centre.

The number of man hours in each service cost centre can be determined through the knowledge of the number of fitters or technicians working in the service cost centre, the normal and overtime working hours during a day, and the number of working days during the year.

The rate of allocating the service cost centre overhead can then be determined as follows:

Allocated rate per hour =

This calculation of the rate should be carried out on the "overhead estimate form" Figure 8.4. On this form the estimated annual materials expenses and depreciation should be entered and added together, and the total cost should then be divided by the number of man hours in the service cost centre, - as calculated in the "labour estimate form" Figure 8.5. The first quarter-of-year estimates should be one quarter of the annual estimate, the rest of the form should be kept blank till the beginning of each quarter; this should allow the control office to change their estimates on a quarterly basis. Each quarter, the last quarter's over, or, under-absorption of the service cost centre cost should be added to the adjusted quarter total and divided by the balance of man hours during the year, (the estimated service cost centre manhour - the actual man-hour at the end of last quarter of year), this should absorb the service cost centre annual overheads.

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Fig. 8.4 SHIVICE COST CLATINE OVERHEADS ESTIDIATE FORM.

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Fig. 8.5 LABOUR ESTIMATE FORM

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	ā	Cost	Ventre Code No.		ננפ	512	513	514	515	51

Fig. 6,6 THE SERVICE COST CENTRES BUTGET FOR THE CENTRAL REPAIR DEFOR

The service cost centres labour estimates should be prepared on a "labour estimates form" Figure 8.5. On this form an estimate of the workers weekly and annual working hours and costs should be determined; the cost of workers should be classified under the appropriate code number - Appendix 3. This form should enable the control office to determine the annual working hours of each service cost centre and their costs; the form also permits the preparation of a quarterly estimate of the worker cost; this should facilitate the revision of the service cost centres budget.

The service cost centres budget

This budget should be prepared for each location of services cost centres - sub codes in the service cost centre code, Appendix 2 - and should cover the initial estimate of overheads and labour as estimated by the 'overheads estimates form' and 'labour estimate form' previously described. The budget covers the revised costs at the beginning of each quarter, and its estimated costs, which should be calculated according to the revised estimates. The previous year's initial, revised, and actual costs are also included in the budget for comparisons. Figure 8.6 represents the service cost centres budget for the central repair depot.

SECTION THREE

The administration cost centres budget

The administration cost centres budgets are a component of the Highways Department administration budget. The administration cost centres have been classified under the cost centres code no. 4 - Appendix two -, and their budgets should not differ except in using the appropriate code number in the budget tables. The administration-cost centres budget should only deal with the fixed costs classified under the cost element main code no. 6 - Appendix three -, and therefore, this code should be the basis for these budgets.

Separate estimates should be prepared for each section in the cost centre representing individual functions under the control of individual managers. The principle of requiring budget estimates, should recognise the requirements of the costing system and at the same time follow the line of the organisation chart, so that responsibility for the cost of running the various departments can be placed squarely on the manager in charge. (12)

1. The Head Office administration budget

Administration costs can be divided into two categories of costs; the first are those costs which can be controlled by the managers of the head office departments, is employment cost, cost of communication, etc., and the second are those costs which the manager cannot control, is. utilisation cost, building occupation costs, etc. It has been suggested in chapter one that the Highways Department Head Office should consist of:

- 1. The County Surveyor and his deputy officers.
- 2. The administration department.
- 3. The design department.
- 4. The maintenance organisation Head Office.

Each of these departments, or offices, should prepare a separate estimate

A W WILLSMORE "Business budgets in practice". Fifth edition. (London, Sir Isaac Pitman and Son Ltd. 1973). p. 126.

for its controllable costs only, which are directly attributable to each of them, and at the same time under the direct authority of each manager. The departmental estimate should be prepared on the "Head Office departmental estimate" form (figure 8.7), i.e. the depreciation, maintenance and running costs of the office equipment should be estimated in detail and then entered onto the form as a total. (If one of the cost elements included in the form does not exist in the department, its estimated-cost column should be kept blank, ie. the administration department may leave the estimate of technical staff blank, as there are only clerical staff in the department.)

The cost elements which are not under the departmental managers' control and/or are difficult to attribute directly to departments and offices in the Head Office, should be approved by the administration department manager. This unallocated estimate and the totals of the "Head Office departmental estimate form" for all the Head Office department and offices, should then be entered onto the "Head Office administration budget table", Figure 8.8. In this form, the unallocated costs should be entered separately to indicate non-allocation to departments but, at the same time, such costs should be controlled by the administration department manager, as he is responsible for controlling the Highways Department expenditure.

2. The division, central repair depot, and central laboratory administration budgets

In general the administration budget does not differ from the Head Office budget, but, as all activities in the division are under the direct control of their managers, all types of costs are allocated to the location depot. Administration cost budgets should be prepared for the location as a whole. The estimates of the location budget, therefore, should be prepared on a "location estimate form" which should be the same as the "Head Office departmental estimate form" described before, but including all the fixed cost sub-groups included in the cost element codes, Appendix 3. The control office in the location should estimate the cost of its location by using the appropriate cost elements in the "location estimate form", a dash line being entered against the cost elements which do not exist in the location.

HEAD OFFICE DEPARTMENTAL ANNUAL AIMINISTRATION COST ESTIMATE FORM.

DEPARTMENT:

Cost Element Code	Description	The annuestimati		Last y	rear
No.		Sub total £	Total £	Estimate £	Actual cost £
611 612 613 614	Printing and stationery Text books Maps and plans Protective clothing	XX XX		XX XX XX	XX XX
61	Total administration materials	xx	XXX	XXX	XXX
6211 6212 6213 6214 621	Salaries Overtime Employment cost Expenses Technical Staff	xx xx xx xx		XX XX XX XX	XX XX XX
6221 6222 6223 6224	Salaries Overtime Finployment cost Expenses	xx xx xx xx	xxx	XXX XX XX XX	XX XX XX
622	Clerical Staff	·	xxx	xxx	хсх
6311 6312 6313 6314 6315	Postage Telephones Radio Telox Radar	xx xx xx xx xx		XX XX XX XX	XX XX XX XX
631	Cost of communication		XXX	XXX	XXX
6321 6322 6323 6324 6325 6326 6327 6328 6329	Conference expenses Entertainment of CC guests Medical examinations Subscriptions Computer charges Laundry Adverts Fees Bank charges	xx xx xx xx xx xx xx		xx xx xx xx xx xx	XX XX XX XX XX XX XX XX XX XX XX XX XX
632	General Expenses		XXX	XXX.	XXX
6341 6342 6343 6344 634	Typewriters Calculating machines Photocopying machines Furniture Office Equipment and Furniture	xx xx xx	xxxx	XX XX XX XX	XXX XXX XXX XXX
			XXXXX		

	γ		11												
	4 800	Dotal			XX			ğ						XX	XXX
reer.	Actual cost	Sub total	¤			¤	¤		¤	ğ	¤	×	¤		××
Last year	Estination	Total			ğ			X						ă	XXX
	rite	Sub total	¤			ă	ă		¤	¤	ŭ	ă	ğ		χαχ
	To+a1				XX			XX						XXX	XXXX
	Sub total		ă	ă		ă	ğ		ğ	×	¤	ğ	ŭ		хээх
	Umallocated Sub total	costs		×						¤			ğ		XXX
no	Mainten. Cryanis.		×			¤	ğ		ă	¤	¤	¤		Tobacco haddened	ΧCX
The annual estimation	Lesign	Depart.	¤			ğ	ğ		ğ	¤	ğ	ğ			χχα
The ann	Traffic	Depart.	ă			¤	¤		ğ	ğ	ğ	ğ			ğ
	Adminis.	Depart.	×			¤	¤		ğ	×	¤	ğ			XXX
	C. Surveyor	Deputy CS Office	ğ			ğ	×		×	ğ	ğ	ğ			XXX
	Description		Administration materials	Utilities	AZIZIZERANION MARERIAIS AND UTITITIES	Technical staff	Clerical staff	ತಾರಿಗೆ ಭಾರತಿಗಳು	Cost of communication	General expenses	Cost of office equipment	Cost of office furnitume	Cost of building occupation	TIXED EXPERSES	TOTALS
	Cost	Code No.			61	621	622	62	631	632	635	636	637	63	v

THE HEAD OFFICE ADMINISTRATION BUDGET TABLE

3. The Highways Department administration budget

The Highways Department administration budget consists of the totals of all the above budgets, and should be prepared in an accumulated table - Figure 8.9. In this Table, only the totals of the Head Office budget, the different locations of the Highways Department budgets, and last years estimated and actual expenses, are included.

The necessary absorption costing of work to be charged out

The Highways Department acts as an agent for the Department of the Environment in carrying out the maintenance and improvement work in trunk roads and motorways. The central repair depot may also carry out maintenance and repair work for other County Council departments' vehicles - police, fire-brigade, etc. - or to other parties, ie. maintaining and/or repairing the Department of the Environment's gritters lorries, and/or snowplough lorries, which may be kept in the divisions depot to be used on trunk roads and motorways when needed. The Highways Department should charge these types of work with the full cost, including administration cost.

It is submitted that the "marginal costing theory" has been used throughout the suggest cost accounting system and, accordingly, the administration costs were not allocated to the cost units and cost centres. Therefore, the cost of the maintenance and improvement work for trunk roads and motorways, carried out by the Highways Department direct labour, and/or the cost of maintaining and repairing the outside parties or the other County Council departments vehicles, carried out by the central repair depot, do not include a portion of the administration costs.

In these cases, the "absorption costing theory" should be employed to determine the full cost of the charged work. The use of this theory does not require any changes in the suggested costing system as all the required calculations and allocation of costs should take place outside the records.

To determine the amount of administration cost to be allocated to the charged work according to the "absorption costing theory", the practical capacity and the total administration costs of the different locations of the Highways Department should be determined in order to calculate

	THE HIGHWAYS DEPARTMENT AIR	MINISTRA	TION BU	DGET			
	From19	To .		19			
Cost Centre Code no.	Description	Admin materials and utilities 6	Employment Cost	Fixed Expenses	Totel Admin. cost	Last y	ear Actual
441 442 443 444 445 446 44 410	Division 1 Division 2 Division 3 Division 4 Division 5 Division 6 Divisions Administration Cost Head Office Central Repair Depot						
430	Central Laboratory Administration Cost Centres						
	Total Cost						

Fig. 8.9 THE HIGHWAYS DEPARTMENT ADMINISTRATION BUDGET ACCUMULATED TABLE

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a rate by which the charged work should absorb its portion of the administration cost.

The administration costs of the Highways Department locations for the purpose of cost absorption

The administration cost budgets, for the Highways Department previously mentioned, present the estimated costs for each location of the department. These estimated costs need some adjustment as a result of the inter-relationships between these locations. This adjustment can be achieved by using one of the existing methods of cost reapportionment which are summarised in the following: (13)

- The direct reapportionment method; according to this method the total service department costs should be reapportioned directly to the production departments.
- 2. The step method; this method recognises services rendered by one service department to other departments, and the sequence of reapportionment should be shown. This sequence should begin with the department that renders services to the greatest number of other service departments, the sequence then being continued in step-by-step fashion ending with the reapportionment of costs to that service department which renders services to the least number of other departments.
- 3. Reciprocal services method; this method recognises that many service departments render reciprocal services and, therefore, the reapportionment of their costs should take place. If the reciprocal services between the services departments are significant, an elaborate scheme of reapportionment involving simultaneous equations may be adopted, and a computer could help in applying this method.

The use of each of these methods in the Highways Department is debateable, therefore, it is necessary to define the needs and the circumstances which necessitate such procedures:-

1. Charging the outside parties with the cost of maintenance and/ or improvement work carried out by the Highways Department on their behalf. This type of work needs the services of the Head Office, which may supply the design and/or the traffic

¹³ C T HORNGREN, op. cit., pp. 571-578.

information for the project, purchase materials etc., the central repair depot which supplies the different items of plant, the central laboratory which may carry out the operation analysis, and the services of the divisional clerical and technical staff and other managerial facilities.

- 2. The cost of preparing tenders, when the Highways Department is bidding for a particular job in competition with contractors. This should be assessed as the total cost, both variable and fixed, and include the appropriate part of the overhead costs of the Highways Department.
- 3. Charging the outside parties with the cost of maintaining and repairing plant and vehicles in the central repair depot services cost centres.

If the Head Office, the central laboratory, and the central repair depot administration cost centre, are regarded as service departments, and the divisions, and the central repair depot service cost centres, are regarded as production departments, the adjusted administration cost for these locations, which should be the basis for allocating the administration costs to the charged work, should be determined according to one of the following alternatives:

- 1. Determining the administration cost which should be charged to the charged work as a percentage of the estimated cost of the operation. This method will not necessitate the reapportionment of the service departments administration costs, or the calculation of a rate for allocating the administration cost to the operations but, on the other hand, it has no theoretical basis, as the allocated administration cost will depend only on the determined rate of allocation.
- 2. Determining a rate per man hour, or machine hour, for all types of work carried out by the Highways Department. In this case the Highways Department administration cost, and its practical capacity (man hour or machine hour) should be the basis for such calculation. The main disadvantage of this method is that the administration cost rate, which will be the basis of allocating the administration cost to the charged work, will be the same for the maintenance and improvement work, and the maintenance

and repair work in the central repair depot service cost centres. The result of this is a high administration cost, allocated to the central repair depot charged work, which may influence the outside parties to find another place to carry out their work; this may reflect on the central repair depot causing idle capacity in the service cost centres (workshops).

- 3. Determining a separate rate of allocating the service department administration cost, for the work carried out by the divisions maintenance, and improvement work, and for the work carried out by the central repair depot service cost centres. This can be achieved by using the "direct reapportionment method" in reapportioning the service departments administration cost to the divisions and the central repair depot service cost centres. In this case, all divisions will be regarded as one department, and the rate per man hour, or machine hour, which should be the basis for allocating the administration cost to operations. will be the same. This will give a constant rate over the whole of the Highways Department's charged maintenance and improvement work. The implementation of this method in the central repair depot should provide a uniform rate which should be used to allocate administration cost to all the charged work.
- 4. This method uses the "step method" in determining the adjusted administration cost of the divisions and of the central repair depot service cost centre. This method recognises the fact that not all offices in the Head Office serve the divisions and the central repair depot, and the central repair depot serve the divisions. The use of this method will mean that the budgeted administration cost of each of the Head Office departments should be the basis of the reapportionment procedures. It also requires the determination of the sequence of reapportionment between the service departments and the production departments divisions and central repair depot service cost centres. This method should give a more realistic result than the other methods, but there is the difficulty of determining the basis and the sequence of the reapportionment procedures.

5. The last method is by using the "reciprocal service method", which recognises the fact that some of the Head Office departments render services to the others, ie. the adminstration department - and, therefore, their cost should be reapportioned to these departments first. The use of this method should make the finding of the basis and sequence of reapportionment a greater problem than it was in method four.

The purpose of this reapportionment procedures is to find the adjusted administration costs of the divisions and central repair depot which should be the basis for calculating the rate by which the outside parties work should be charged. This represents a recovery of a part of the Highways Department fixed costs according to the load of work executed for the outside parties, therefore, the use of the third or fourth method described above is recommended. It should be noticed that the difference between using the fourth method instead of the third is that, the readjusted administration cost for the divisions will be higher and for the central repair depot will be lower, than in the third method. The use of the fifth method may give a more accurate result but the difference in the final rate of allocation will not be significant.

The calculation of the rate of absorption

The rate of calculating the allocated administration costs to the charged work can be determined through the use of one of these alternatives:

1. The machine hours. A rate per machine hour can be calculated for the divisions and for the central repair depot, according to the annual programmed work of mobile plant for divisions and established plant in the central repair depot, which can be regarded as the practical capacity of the divisions and the central repair depot. The use of the machine hour as a basis does not represent the work throughout the Highways Department, as a significant number of operations may be carried out without the use of either the mobile plant or the establishment plant.

- 2. The labour hours. This is a realistic method which is recommended to be used in calculating the rate of allocating fixed costs to the charged work. The practical capacity of the department in this case should consist of the total man hours included in the maintenance and improvement work in all divisions, and should consist of the fitters hours included in the services cost centre programme of work. It is possible to use the total fitters hours in each service cost centre to determine a separate rate for the service cost centre, and for calculating a separate rate for maintenance and improvement work. These rates can be calculated as follows:
 - 2.1 The calculation of one rate for all types of work in the divisions and service cost centres in the central repair depot.
 - **2.1.1** The divisions rate per hour =

Adjusted divisions administration cost
Annual programmed man hours in all divisions

- 2.1.2 The central repair depot rate per hour =

 Adjusted central repair depot administration cost
 Annual programmed fitters hours in all services
 cost centre.
- 2.2 The calculation of a separate rate, for each type of work in the division and for each service cost centre in the central repair depot, should be prepared by first determining the administration costs which should be allocated to each type of work or service cost centre; this can be calculated as follows:

The adjusted administration X The type of work or service cost of the location Cost centre programmed man hours. The divisions or the central repair depot total man hours

The administration cost allocated to each type of work, or to each cost centre, should then be divided by the appropriate programmed man hour of each of them, to present its rate of allocating fixed costs to the charged work. The administration cost which should be absorbed by the charged work should be determined according to the actual capacity used in the operation, also the tenders should be charged with administration costs according to the estimated man hours required to carry out the work. This can be calculated by multiplying the actual or estimated number of man hours used, or required for the operation, by the appropriate rate of recovery calculated by using one of the above mentioned methods.

SECTION FOUR

The purchase budget

The preparation of a purchase budget should help the Highways Department in securing bulk buying, and in using tender for all types of materials; this will enable the department to gain some discount over its purchases which will help in minimising the total cost of materials used, and this will be reflected in the costs of all work carried out by the department.

The preparation of the purchase budget should also help in carrying out the "Marshall Report" recommendation which cited:

- "A county authorities should, if they are to gain maximum benefit, include the need for their constituent authorities in the quantities on which the annual tender is based.
- B Authorities should order materials in bulk whenever possible, if necessary co-operating with their neighbours."(14)

The materials' budgets for the divisions maintenance and improvement work, the central repair depot spare parts (and other materials) and the central laboratory materials, which indicate the number of units required of each type of materials, should be transmitted to the purchasing department when completed. Based upon this data, and management policies with respect to materials inventories, computation of the units to be purchased is possible. Once the units to be purchased are determined, it is necessary that the timing of purchases be planned in a manner consistent with the inventory policy. (15)

In the Highways Department there are two types of materials; the first type includes those materials which are delivered directly to sites on a daily basis, and the second includes those materials which are kept in the divisional or depot stores; therefore, policies and procedures for purchasing each type should differ.

Report of committee on Highway Maintenance. op. cit., p. 53.

¹⁵ G A WELSCH, op. cit., p. 65.

1. Materials delivered directly to sites

Materials delivered directly to site represent those materials required for the major maintenance operations and improvement operations. These types of materials have no inventory problems as they are not stored in the Highways Department stores. The appropriate purchase offices and departments should be responsible for preparing their purchase budgets according to their responsibility. (16)

The purchase budget for this type of materials should be prepared according to the operational materials budgets and programme of work. This requires the use of a "Materials monthly requirement form" - Figure 8.10 - which should be prepared for each item of materials separately. On this form information on the location of the sites, the cost and quantities of materials required for each operation, and its distribution during the month should be brought forward from the operational material table, and information about the suppliers is also included in the form to facilitate the ordering procedures of materials during the year. The total of each form should represent the total costs and quantities of materials to be purchased every month.

2. Materials delivered to the Highways Department stores

This type represents those materials which should be kept in the divisional stores, central repair depot store, and central laboratory store. The determination of the optimum level of inventory and appraising the decision rules for ordering inventories are two of the most difficult problems facing management. There is a danger that management may ignore the problem of inventory control and incur various unnecessary costs that accompany excessive inventories, or not have a sufficient number of units in hand; many of the costs arising from excessive inventory

The responsibilities of the division and head office purchasing offices has been described in chapter one.

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Fig. 8.10	

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		Suplier	lame & Address		
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		Distribution of Materials during	week Four	524 EH 3-2	
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s negronmanox	T THE COURT		Week Three	T % T	
maderlas montentas recuterantes form 10.			Week Iwo	W T B	
Portenta icotema r Porteno.				ह - प्र स	
M.A			Wock One	H H H	
		Material	Total quantities Frice per unit		
		Haulage	Cost Hired lorries C.Council lorries		
	No:		-	tal	
	CATHELAL COST ELECTR CODE No:		Location of site		TOTALS
	MINITAL		Operation Code No. Division Code No.		

appear to be normal, and on the other hand the cost of not having enough inventory represents extra costs. $^{(17)}$ There are two central questions which must be faced in designing an inventory control system.

First, how much to order.

A classical model (18) has been formulated to determine the economic quantities for ordering. The theory underlying this is to determine the quantity which has the minimum associated variable costs with the inventory. The variable cost of inventory is assumed to be a function of two costs; the cost of ordering and the cost of carrying the inventory. Given the annual requirement for an item, the ordering cost, expressed in cost per order, will vary inversely with the average annual inventory, and the cost of carrying, will, conversely, tend to vary with the average annual inventory. (19) The economic order quantity, and the cost of inventory, can be calculated according to the classical inventory formula as follows:

$$Q = \sqrt{\frac{2RO}{IU}}$$

$$C = \sqrt{2ROIU}$$

where

Q = economic order quantity

C = the cost of inventory for the economic
 quantity

R = annual requirement in units

0 = ordering cost per unit

U = unit cost of the inventory item

H BEIRMAN, Jr & A R DREBIN "Managerial accounting: an Introduction" second edition (London, Collier-Macmillan Limited. 1972) p. 175.

A modification to this classical model has been presented by E H BOWMAN and R B FETTER "Analysis for production and operation management" (Illinois, Richard D Irwin Inc., Homewood. 1967)

pp. 318-320 & 328-330.

 $^{^{19}}$ W A TERRILL & A W PATRICK, op cit., pp. 619-625.

Another method widely used in practice is "the constant order - cycle system"; according to this system the level of inventory on hand must be reviewed every month to bring the quantities on hand, and on order, up to a certain level. The order date should be fixed, and the quantities ordered depend on the usage since the previous order and the outlook during the lead time; demand forecasts and seasonal patterns should be considered in specifying the size of order during the year. This method should be adopted when the cost of continuous surveillance is too high or when ordering and transportation economies may be gained through regular ordering of several items from the same supplier. The major disadvantage of this system is that it may require carrying more safety stock to protect against stockout not only during the replenishment lead time, but also during the period between the placing of orders. (20)

The availability of the annual quantities of materials required for the division should not present any sort of difficulty, but the forward availability of spare parts is difficult, as the problem lies in the dependence upon external manufacturers for supplying the required spare parts. This activity is not the primary purpose of the manufacturers and, therefore, when demand is irregular, the fixing and sustaining of spares in stock presents problems which may affect delivery. This may make it necessary for the central repair depot to keep a range of spare parts, in uneconomic quantities, to overcome this problem. GRADON, suggests some policies, which should be the aim concerning spare parts stocks; these policies are:

"The avoidance of unnecessarily high inspection standards resulting in the premature scrapping of components.

The highest economic recovery of components for re-conditioning and re-use.

The establishment of quantitative, phased forecasts of demands, based on past trends and the programmes envisaged.

²⁰ C T HORNGREN. op. cit., pp. 545-546.

The maintenance of reasonable stocks, based on the best delivery condition obtainable, and centralised so that the minimum holding affords maximum coverage. This is aided by the curtailment of work outside the central workshops.

The regulation of the demand and holdings so that they become based on recorded usage over appropriate periods, instead of relying on estimated forecasts and likely demands.

Giving manufacturers adequate reliable forecasts of demands so the level of work handled increases." (21)

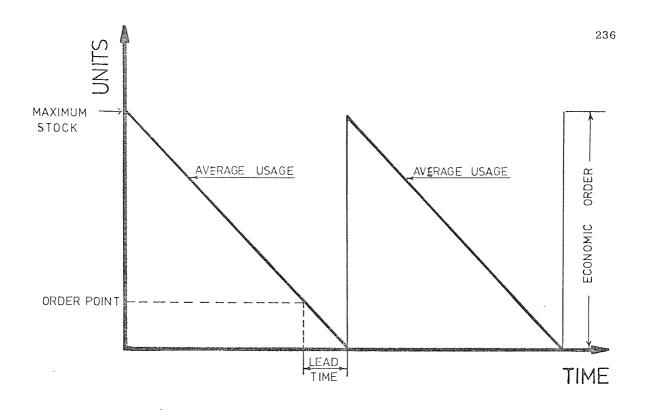
From the estimate of the plant cost centres running cost form, the deputy plant engineer should prepare a list of initial spares for each plant cost centre, and the purchase office should then take the appropriate procedures to purchase and store these spare parts.

Second, when to order.

The time of ordering the economic quantities of each item of materials depends on the knowledge of the time between placing an order and receiving delivery - lead time - and on the expected usage during this period. In the Highways Department, there are items of inventories which have a certain demand during the lead time, (this can be determined by the use of "the material monthly requirement form" - Figure 8.10) and others where their demand is not known with certainty. In the first case, the order point would be placed when the quantity in stock reaches the point which equals the demand at the lead time, but, in the second case, (when the demand is not known) it is necessary to provide some safety stock which should be the minimum inventory to be kept in store against reasonable expected maximum usage. These relations can be shown in Figure 8.11.

F GRADON 'Maintenance Engineering: Organisation and Management' (London, Applied Science Publication Ltd. 1973.) pp. 68-69.

There are a number of methods for estimating the expected demand during the lead time, for details see R G BROWN "Statistical Forecasting for Inventory Control" (London, McGraw-Hill Book Company, inc., 1959). pp.136-159 and 175-185.



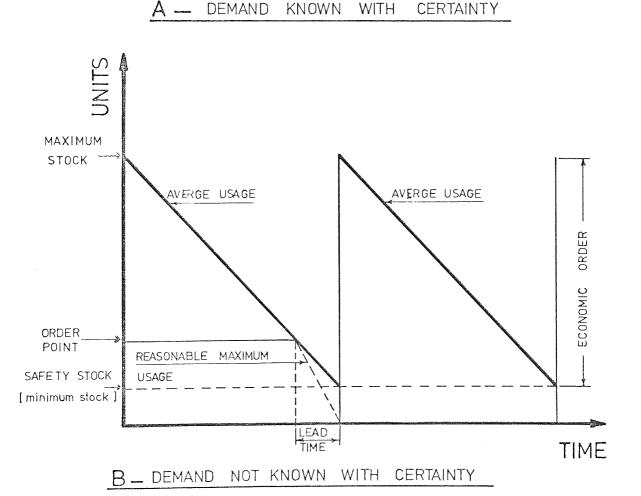


FIG.841 DEMAND IN RELATION TO INVENTORY LEVELS

The quantities of monthly purchased materials (of each item of stored materials included in the purchase budget), should be prepared according to the determined economic size and its order point. This means that the amount of materials to be purchased during the month should be always the economic quantity, i.e. the initial inventory should cover the maximum usage during the month and during the lead time. If this is not achieved, a new order should take place during the month, and the total cost should be budgeted for in "the estimated monthly purchases of materials delivered to store form" Figure 8.12, which should be prepared for each type of materials.

The purchase budget

The purchase budget - Figure 8.13 - should be prepared in each location of the Highways Department, and then added together to present the departmental purchase budget. It should be prepared on a quarterly basis. This means that there should be four budgets, each one covering the monthly purchases required during each month, and the totals of the other three quarters of the year - the second quarter budget should include the actual quantities and cost of purchased material and the estimated cost of the rest of the year, and so on. The monthly estimates should facilitate the revision of prices on a monthly basis, this will keep the budget up to date with actual prices in the market.

The budget should include both materials delivered directly to sites and to the Highways Department stores. Entries in this budget should be through the appropriate materials estimates form described before, and this means that no extra work is needed to prepare such a budget.

(1) Last month initial inventory(2) The economic quantity

Fig. 8.12 (The estimated monthly purchases of materials delivered to stores form)

	to the second		-	Total cost		
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	Total. "Ammal"	THE PERSON NAMED IN COLUMN 1	laterial			
				Quintities		
				Tota	ul cost	
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		Four		ن ا	Material	
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				Total cost		
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			Tota	l cost		
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				Quantities		
				Tota	al cest	
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	TASES TO:			Quantities		
	PURC		June	Total cost		
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	NS A	urter		L	Material	
	TOTE:	First quarter	May	Quantities		
	H F	Firs		Tota	al cost	
	~			Cost	Haulage	
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CHAPTER 9

THE HIGHWAYS DEPARTMENT REPORTING SYSTEM

This chapter will be divided into the following sections:

Section One: Theoretical survey of reports and its application

in the Highways Department.

Section Two: The framework of the reporting system for the

Highways Department.

SECTION ONE

Theoretical survey of reports and its application in the Highways Department

The fundamental purpose of management accounting is to inform on the achievement of an enterprise's operations; such information is collated and disseminated to the various levels of the management. (1) The information presented to management should take the form of statements or reports, and it is axiomatic that such reports should state clearly what they intend to convey. (2)

The broadest definition of reports has been given by LESIKAR, he states:

"Reports are almost any presentation of information ranging from the extremely formal to the highly informal."(3)

He also defines business reports as:

"A business report is an orderly and objective communication of factual information which serves some business purpose." (4)

Control reports, which are used for controlling the cost and performance of operations within an enterprise have been defined by DEW and GEE, they state:

- "Control reports are documents which state performance and meet the following requirements:
 - 1. Having a fixed formal and/or typographical layout.
 - 2. Presented at regular intervals.
 - 3. To a specified manager or group of managers.
 - 4. For purposes of comparison; the comparison might be in the report itself, or it might be left to the manager to make his own comparisons." (5)

H DUGDALE, "Reportage in management accounting system". The Commercial Accountant, Vol. XXI, No. 4, October 1970, p.301.

J A SCOTT, Op.cit., p.93.

R V LESIKAR, "Report writing for business" Third edition (Illinois, Richard D Irwin Inc. Homewood, 1969) p. 1.

⁴ Ibid. p.l

R B DEW & K P GEE, "Management control and information" First edition (London, The MacMillan Press Ltd., 1973) p.38.

Reports are not in themselves control; they are intended to provide managers with a factual basis for the execution of their duties. Reporting for cost control is also not the only means of control or necessarily the most effective means of control; for daily operating control - the alertness of individual workers and supervisors through a visual control over resources - can be more effective than reports, and, days before the report is prepared, action can be taken to correct any variances. However, reports are needed to show the level of efficiency even after such action has been taken. higher levels of management, reports provide information about the performance of subordinates and the execution of plans; this should inform top management that delegated authority is being carried out For those elements which appear to be out in a responsible manner. of control or departing from the plan, comments in the report can indicate: a tentative analysis of causes, the results of lower-levelof-management action taken on the spot, and the need for considering other controls measured by appropriate personnel higher in the Formal control by reporting provides information and organisation. communication to those having final responsibility, who can also assist in taking effective control actions, and therefore, these reports should employ any combination of techniques which are effective and feasible in the circumstances. (6)

The reporting system should be designed to fulfill the requirement of the management by exception concept, which is defined by BITTEL, as:

"A system of identification and communication that signals the manager when his attention is needed, conversely, it remains silent when his attention is not required." (7)

This concept means that the busy manager should devote his time to the unusual or exceptional items, rather than worry about those matters that are not out of line; as dealing with the out of line items is enough of an accomplishment for him. (8) The management-by-exception concept

⁶ W A TERRILL and A W PATRICK. Op.cit., pp.481-482.

L R BITTEL, "Management by exception systematizing and simplifying the managerial job" (London, McGraw-Hill Book Company, 1064)p.5.

⁸ G A WELSH. Op.cit., p. 33.

necessitates that costs should be accumulated and reported by level of responsibility within the enterprise; each supervisory area in the organisation should be charged only with the cost for which it is responsible and over which it has control. (9) In other words, the management-by-exception concept requires the employment of responsibility accounting in the enterprise, in order to gain from this concept.

Responsibility accounting has a natural appeal because it specifies a boundary of operations, and distinguishes between controllable and uncontrollable costs. It is easy to say that a manager's performance should be judged on the basis of only those items subject to his control, but in practice, it is not that easy to differentiate between controllable and uncontrollable costs. HORNGREN, mentioned that:

"Controllability is a matter of degree that is affected by two major factors: the managerial area of responsibility and the time period in question. All costs are controllable to some degree and by somebody, over the long run. In the short run, not as many costs are controllable, and those that are controllable are subject to various degrees of influence." (10)

The report of a committee on: 'Tentative statement of cost concepts underlying report for management purposes' suggests some guides to identify the controllable costs which may be charged to persons 'responsibility centres'. These guides are the following:

 If the person has authority over both the acquisition and the use of the service, the cost of such service should be controllable cost, and he should be charged with such cost.

⁹ C T HORNGREN. Op.cit., pp.5-6.

^{10 &}lt;u>Ibid</u>. p.273.

REPORT OF COMMITTEE "Tentative statement of cost concepts underlying reports for management purposes" Accounting Review; April 1956 p.189.

- 2. If the person can significantly influence the amount of cost through his own action, this cost should be controllable and he may be charged with such a cost.
- 3. If the person cannot significantly influence the cost, he may be charged with the cost of those elements with which top management desire him to be concerned.

In employing management-by-exception in the enterprise, management may decide to allow a predetermined percentage of variances before reporting to the responsible manager; this is justified by assuming that: investigating the cause of small mounts of variances is not necessary, the variances within the percentage limits represent an allowable variance in this type of work, future performance would not improve even if the cause of variances was identified, or the cost of investigation may exceed the benefits gained from investigating the cause of the The traditional thoughts on this problem in the cost variance. accounting literature, are in terms of business judgment. FOURAKER and JAEDICKE present a model by which management can decide to investigate, or not to investigate, variance. (12) According to this model, a cost control decision chart should be prepared by using the various possible variances to a given budget activity, deriving the critical probability for each possible variance. This critical probability is used to prepare the curve separating the 'investigate' and 'do not investigate' areas in the chart. By standardizing the distribution and then by the use of a normal probabilities table which should be converted to match the scale used in the chart, for the actual variance - the probability of this variance can be determined. The amount of variance and its probability should then be plotted on the chart. If this combination (variance and probability) falls in the 'investigate' region, then the variance should be investigated, and if it falls in the 'do not investigate' region then management should not investigate this variance. The use of this model should facilitate management-by-exception as applied to cost control.

H BIERMAN, L E FOURAKER and R K JAEDICKE. "A use of probability and statistics in performance evaluation" The Accounting Review, July 1968, pp. 409-417.

The practice of management-by-exception in the reporting system should give the enterprise the following advantages. (13)

- 1. Save the manager time, as it minimizes time spent on trivia and details that other members of staff can handle.
- 2. Concentrates managerial effort, as a manager will place his effort selectively only where it is needed instead of spreading his managerial talent over all sorts of problems.
- 3. Lessens the frequency of decision making; the system passes over only those important problems for the manager to act upon.
- 4. More fully utilizes highly paid people on high-return work, because delegation is planned; it carefully relates and assigns the more complex problems to the more talented and highly paid people in the enterprise.
- 5. Provides qualitative and quantitative yardsticks for judging situations and people. Management-by-exception takes much of the prejudice out of the performance appraisals for making individual and organisation goals and measurement tangible and specific.
- 6. Stimulates communications between different segments of an enterprise; with its focus on results, management-by-exception seeks to relate causes, regardless of their place in the enterprise, with the overall enterprise results. As such, it encourages exchange of measurements between functions as well as between function and the cost centre to which it reports.

LEWIS, mentioned that (14) in a good effective report, the reported fact should in some way be related to a specific action or series of actions which are regarded as the responsibility of a specific individual in the enterprise. He also mentioned that the report should reveal

¹³ L R BITTEL, Op.cit., p.5.

R B LEWIS, "Accounting reports for management" (New Jersey, Englewood Cliffs - Prentice-Hall Inc., 1957) p. 35.

the trend or movement as 'favourable or unfavourable' over a period of time, and that this might be indicative of the trend in the future. In this way, LEWIS suggests that the need for corrective action is indicated in the report before unsatisfactory operations have actually turned seriously out of line, and corrective steps are then taken as a preventative measure. (15)

ROBINSON criticizes the orderly system of classifying reports; he mentioned that the existing common systems in which reports are related to a time factor (daily, weekly, etc.), activity or subject factor (sales, finance, etc.) or degree of formality (formal-informal) serves a unique purpose and contributes to an understanding of certain matters associated with the preparation and use of the report.

However, there is an almost unavoidable tendency for time, subject, and formality systems of report classification to overlap. It is reasonable, in the formal course of events, for management to expect an informal weekly sales report; a type of report that would apparently fit into the three types of classification simultaneously, and this may cause confusion over the real nature and purpose of such report. (16)

ROBINSON suggests that a functional system of report classification, which is based on the nature of report contents, should be used to overcome the previously mentioned confusion. This system is roughly divided into the following categories: (17)

- 1. Informational reports, which represent those reports which are directed primarily to inform managers and restricted to the informative function alone, e.g. the balance sheet.
- 2. Examinational reports, those reports that are directed primarily to examining the information presented to managers, leaving decision-making to them, as they may hold that the reports they receive should only serve to define and explain a function.

 Information presented in this type of report focusses on the problem rather than on a solution to the problem.

¹⁵ Ibid. p.35.

D M ROBINSON. "Writing reports for management decisions" (Columbus Ohio, Charles E Merrill Publishing Co. 1969) p.33.

^{17 &}lt;u>Ibid.</u> pp.34-43.

3. Analytical reports, which are designed to present information to managers and examine its significance, draw related conclusions, and perhaps present recommendations. In this type of report, information should be presented in a logical framework of written analysis and interpretation which suits the needs of the manager.

Indeed, this type of classification is more accepted than the orderly systems of classification as it facilitates the classification of the enterprise reports.

In order to benefit from a reporting system in an enterprise it should be based on a well developed costing system to provide all levels of management with operating statistics, comparisons of actual and budgeted costs, and a tentative analysis of causes of significant variances in performance. The costing system is not the only source for reports, as it also depends — to some degree — upon accounting analyses, statistical analyses, engineering analyses, or a combination of these. The quality of any report depends upon the thought and care devoted to the preparation of such analyses. (18)

In designing and preparing reports, it is important to keep in mind that managers may have a limited knowledge of accounting, and that the report is prepared to serve managers and not the report maker; therefore, aspects relating to the preparation and presentation of reports should be considered before presenting reports to the different levels of management. This should cover the following:

1. The report must show, where appropriate, the period of time to which it relates, the date at which it is rendered, the units in which any quantitative information is expressed, and the name and rank of the person to whom it is presented. (20)

W A TERRILL and A W PATRICK, Op.cit., p.482.

¹⁹ G A WELSH, Op.cit., p. 366.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS. "The presentation of information to management" January 1952, p.7.

2. The method of presentation should, as far as possible, be suited to the mentality of the person using it, to the purpose for which it is required, and to the possible action which may ensue, (21) because, whatever information is being imparted, the individual to whom it is directed will react and respond only if the method of presentation makes a definite impact on him, and so creates interest. (22)

The array of communication media available in presenting information to the different levels of management has been outlined by N.A.A. as, written forms of communication, graphic media and oral communication. N.A.A. mentioned that some selectivity must be exercised in determining the media to be used in the enterprise, and emphasized that a combination of these media is usually more effective than any single one used by itself. (23)

In the written forms a general style layout, and wording should be as simple as possible; the more this aim is achieved the more effective will the report be in its purpose. (24) Graphs are the best available media for showing broad general trends and are invaluable for giving a lucid impression of the current general situation, and therefore, it should be clearly presented. (25) On the other hand, oral reports should be used with care or eliminated completely from the reporting system, since their value is quite dubious, and they are short-lived and often inexact.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "Report to supervisory level of works management" December 1961, p.16.

N.A.A., "Presenting information to management" N.A.A. Bulletin Research Series No. 28, Vol. 36, December 1954, p.637.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "The presentation of information to management" Op.cit., p.11.

²⁵ J A SCOTT, <u>Op.cit.</u>, p.120.

K G TIFFANY, "Reports for management" Edited by W E Thomas
"Reading in Cost Accounting and Control" Second edition (New York,
South Western Publishing Co., 1960) p.731.

3. The timing and frequency of presentation 'timeliness' should be examined, because control of production efficiency and cost is partly a matter of timing. DEW and GEE mentioned that a major reason given by managers answering the question - why a great deal of information presented in the report is not used? was that, information was received so long after the period in which it related, so that it was no longer a guide to effective action. (27) Therefore, the time required for preparing reports should be reduced to a minimum; for routine reports the period should be known, agreed and adhered to rigidly. An out of date report does not only present a waste of time and effort, but may also cause either wrong decisions, a deferrment of decision on a matter which may be urgent, or even a complete failure to realise that action is needed. (28)

The question of timeliness and accuracy of information in the report are related. It is certainly better to have information based on some approximation, in time to take action, than it is to have absolutely accurate information after it is too late to take corrective action.

Generally, reports should be completed and circulated as soon as possible after the event being reported, to enable prompt action to be taken.

The Institute of Cost and Management Accountants mentioned that the frequency of subsequent presentations depend upon the following

- factors: (a) cost of compilation
 - (b) administrative possibilities
 - (c) the period covered by the report or statement
 - (d) the nature and purpose of the report and
 - (e) the speed of action which can be taken on the information given.

²⁷ R B DEW and K P GEE, Op.cit., p.46.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "The presentation of information to management" Op.cit., p.13.

²⁹ R I DICKEY, <u>Op.cit.</u>, pp.20.43.

At the same time, the overriding consideration must be the time that elapses between the end of the period covered and the time required for compilation, circulation, discussion and implementation of action or remedy on the report. (30)

4. The reports should be so constituted as to require a minimum of time both in preparation and even more particularly in consideration. The Institute of Cost and Management Accountants explain this by stating:

"The complexities of present-day management, and the demands made on important executives, are such that there is rarely time available for the detailed study of voluminous reports and statistics. Reports should therefore be as brief as is consistent with pertinence and clarity. The form should be such that salient points are immediately apparent, summary results should stand out to catch the eye first.

The aim should be to produce a precise concise statement, which leaves nothing unsaid that should be said, and nothing stated beyond that which is required to present a clear cut picture of the matter being reported.

'Padding' and verbose expression must be avoided at all costs." (31)

5. Effective use of reports requires team work between the accountant and the operating personnel; it also necessitates the recognition of the need for a follow-up on the information presented in the reporting system. (32)

It is important to determine the relevant information which should be included in the reports presented to the different levels of management in order to enable them to use the reported information as effectively as possible. ACKOFF explains the effect of

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "Report to supervisory level of work management" Op.cit., pp.18-19.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "The presentation of information to management" Op.cit., p.14.

W A TERRILL and A W PATRICK. Op.cit., p.484.

presenting extra information to managers by stating the following:

"Most managers receive much more data (if not information) than they can possibly absorb even if they spend all their time trying to do so. Hence, they already suffer from an information overload, they must spend a great deal of time separating the relevant from the irrelevant and searching for the kernals in the relevant documents... Unless the information overload to which managers are subjected is reduced, any additional information which a reporting system makes available cannot be expected to be used effectively." (33)

Providing managers with extra information, will not help them in taking the corrective action required and may force them to ignore the reports completely; this may lead to serious problems created by the misjudgment or misunderstanding of the real situation in his department. Management require certain types of reports which provide them with either decision rules or performance feed-back reports, so that they can identify and learn from their mistakes. The reporting system, therefore, should be designed according to a careful identification of information needed for the different levels of management.

In general, top management should be able to use management-by-exception in reviewing departmental performance, and their reports should be summarized by totals only. This should enable them to discover weak areas quickly and study the details of particular reports where study seems necessary, rather than be forced to review all aspects of departmental performance.

Middle management is expected to concern itself with the translation of policy into action and with the making and implementation of day-to-day decision. For such purposes, middle management should commonly and regularly receive control information, therefore, the reports presented to them should provide them with information which will assist them in administering policies and in appraising the performance of subordinates.

R L ACKOFF, "Management misinformation systems" Management Decisions, Part 1, Vol. 2, 1966 pp.4-5.

The direct supervisor's level of management represents the area of activity in which specific and detailed reporting is required, as it is important to analyse and report upon expenditures made and results produced. It is at this level that planned performance is tested, the budget is appraised, and proof is given to proper planning and proper selection of materials, manpower and plant. (34) The foreman or superintendent should be treated as the first level of STOCKMEYER mentioned in his article, 'Helping the foreman control costs', (35) that the old concept which treated the foreman as a man whose job is to get out production should be changed, and he should be treated as a controller and not as a ruler. management, which keeps performance and cost figures and their control away from its foremen, operates its operations without its best control and, as a result, possible savings are lost, as they are responsible for controlling the operation costs. It is logical to locate the control of these costs with the foremen and this should make them fully gain from this, management should ensure that the foremen are familiar with the costing system so as to put them in a position to understand the control reports and co-operate with those who are responsible for cost control. The Institute of Cost and Management Accountants examines the lack of reporting to foremen as a result of the belief that: (1) foremen do not need, (2) do not want or (3) would not understand, the cost control report, and present the following conclusion:

"None of these three contentions can be considered valid. Firstly, a foreman generally has more control over company controllable costs than the majority of executives. This is because controllable costs are, in the main, variable costs ..., that is costs that foremen can most influence. A foreman therefore, is exceptionally well placed to control effectively day-to-day costs and assist in cost reduction. Clearly he cannot do this unless he is aware of the direction his efforts take. Secondly, it is not true that foremen do not want information presented. Certainly, they

R I DICKEY, Op.cit., pp.20,42.

R E STOCKMEYER, "Helping foremen control costs" N.A.C.A. Bulletin Section 1 February 1954, pp.751-752.

themselves may not know quite to what use they could put such information and therefore they are reticent to ask for it. However, such uncertainty relating to the use of the information could be remedied by suitable training ..., and indeed it is wholly in the interests of management that such uncertainly be dispelled.

Finally, inability to understand reported information is indicative of one of two positions; either management has neglected to train their foremen in any of the essentials of supervision, or the cost accountant is incapable of reporting such information in the way he should, if he is to uphold his claim to professional ability."(36)

The reports presented to foremen should be relevant, brief, simple and well designed; elaborate reports should be avoided since they require time to obtain a full appreciation of all facts disclosed. If all the above is achieved, foremen will be capable of understanding information presented to them, provided that it is presented at the correct time, and take the corrective action required to control costs.

The Reporting System in the Highways Department

The reporting system, designed for the Highways Department, should be based on the management-by-exception concept, in order to gain from its advantages. Reports should be presented to the different levels of management according to their responsibilities and authorities - as outlined in Chapter One - and should follow the organisational lines. This is to allow the use of responsibility accounting in the system. The reporting system should cover all cost elements used in carrying the work in the different cost centres, and required to complete the operation - cost unit - work.

The reporting system should cover variance reports, which report the variances between the actual and budgeted cost and performance, action reports, which should report the corrective actions taken by the responsible manager to overcome these variances, graphical reports, and informational reports.

The framework of the suggested reporting system will be described in the following section.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, "Report to supervisory level of works management" Op.cit., pp.27-28.

SECTION TWO

The framework of the reporting system for the Highways Department

The framework of the suggested reporting system consists of the variances reports, the action reports, the graphic reports and Informational reports.

1. The variance reports

The variance reports should report the variances between the budgeted and actual costs for all functions of the Highways Department. The report should be in the form of examinational reports described before, and should be presented to the different levels of management according to their responsibility and ability to take corrective action.

Introduction to the variances analysis and its application in the Highways Department

The difference between budgeted and actual costs is known as a "variance" or "variation", (both terms are used in the cost accounting literature - but the term "variance" will be used in this research in reference to this phenomenon). (36) A variance may be either favourable (positive value (+)) which occurs when the actual cost or quantities are less than those budgeted, or unfavourable (negative value (-)) which results when the actual costs or quantities are greater than the budgeted costs or quantities.

The general approach to variance analysis is to calculate the total variance first and then to sub divide it into, (1) price or rate variances, and (2) usage or efficiency variances. (38)

C F SCHLATTER & W J SCHLATTER "Cost Accounting" Second Edition (London, John Wily and Sons Inc., 1957) as cited by R I DICKEY op. cit., discussed the two terms and concluded that "variation" is the better word for this purpose, but "variance" can be said to be the correct word because of the sanction of special usage by cost accountants.

³⁷ H BIERMANN, Jr & A R DREBIN, op. cit., p. 116.

³⁸ C T HORNGREN, op. cit., p. 150.

should be used for the analysis of variances for each cost element separately, in order to help management in measuring variances in terms of responsibility; at the same time, the size of the variance should be used to measure management efficiency in controlling costs. (39)

Usually, variance analysis is applied to materials, labour, and overhead costs, but according to the suggested cost accounting system described before, variance analysis for the cost units "operations" cover a) material, b) labour, and c) plant variances, and substitute plant variance with expense variances in the cost centres. The service cost centres also require the analysis of overhead variances.

a) Material variances

The cost variance of materials represents the difference between the actual cost and the budgeted cost, which may be the result of price and/or quantity or usage variances.

LANG, McFARLAND and SCHIFF, state that:

"Material price variance may be caused by (1) fluctuation in market price of materials; (2) purchasing in non-standard lots; (3) purchasing from unfavourably located suppliers, thereby incurring additional transportation costs; (4) excessive shrinkage or losses in transit; (5) payment of additional charges for special handling or faster transportation; (6) purchasing from suppliers other than those offering most favourable terms; or (7) failure to take cash discounts available". (40)

On the other hand, DICKEY, mentioned that the cause of variances, resulting from using more or less than the budgeted quantities, may be caused from one of the following causes:

- 1. Changes in design of product, machinery, tools, or method of processing not yet recognised in standards.
- 2. Substitution of nonstandard materials.
- 3. Variations in yield from materials.
- 4. Carelessness in not returning excess materials to stockroom.
- 5. Loss or destruction of materials by inadequately trained, poorly supervised, careless, or dissatisfied workmen.

S B HENRICI "Standard Costs for Manufacturing" Third Edition. (London, McGraw-Hill Book Company, 1960) p. 253.

T LANG, W B MCFARLAND, & M SCHIFF. "Cost Accounting" New York, The Ronald Press Co. 1953 as cited by R I DICKEY, op. cit., p. 17.3.

- 6. Too rigid inspection.
- 7. Lack of proper tools or machines.
- 8. Failure to keep machines and tools in good working condition. (41)

A widely accepted method of calculating material price and usage variances is as follows: $^{(42)}$

usage variance = (budgeted quantity -Actual quantity) x budgeted price
price variance = (budgeted prices - Actual prices) x Actual quantity.

In the Highways Department there are two types of materials: (a) materials delivered directly to sites to be used there, and (b) materials delivered to stores in economic quantities and then issued from stores as required. In the first case, the price variance should refer only to the materials used on site; assuming that all materials delivered to site are used — and, in the second case, the price variances should refer to materials purchased and delivered to the stores and not materials used on sites or cost centres.

b) Labour variances

Total labour cost variances are caused by variances in wages rates and/or variances in working hours for the work done. The budgeted wages rate needs to be kept up to date with uncontrollable factors, such as union negotiations and/or local conditions of labour supply and demand. The labour rate of wages should also be changed according to variances resulting from such factors.

⁴¹ R I DICKEY, op. cit., p. 17.5.

From those who accept this method of calculating variances, R N ANTHONEY & G A WELSCH, op. cit., P. 447, W A TERRILL & A W PATRICK, op. cit., p. 363 & M BIERMAN & A R DREBIN, op. cit., p. 107. The second view of calculating materials variance, calculate price variance as the difference in price multiplied by standard quantities, and the quantity or usage variance as the difference in quantities multiplied by the actual prices. The difference between the two views concerned with the responsibility for excess price paid for excess materials, see, O A SHATA, "Analysis of Cost Variance for Planning and Control" unpublished MSc dissertation. Faculty of Commerce and Social Science, University of Birmingham 1974. pp. 50-52.

The analysis of labour variances should deal with the controllable factors only, and should be regarded as the responsibility of management. HORNGREN regards the foreman as being responsible for variances caused by all or one of the following causes:

- "(1) the use of man with a wrong rate for specific operation
 - (2) the use of excess man per machine, or
 - (3) paying expensive day rates because of low productivity instead of prescribed price rates." (43)

On the other hand, BLOCKER and WELTMER, mentioned some causes which should not be the foreman's responsibility; from these causes: (44)

- paying the workers above or below standard rates during seasonal or emergency operations
- 2. paying guaranteed day rates to workers who are not able to earn the established price rare
- 3. new labour not paid the established rate.

The responsibility for such causes of variance should be clearly identified in the enterprise, and should be reported to the person responsible.

Labour variances can be calculated in the following manner:

Rate Variance =

Budgeted Rate - Actual Rate x Actual working hours

Efficiency Variance =

Budgeted number Actual number x Budgeted rate of working hours per hour

c) Plant variances

Plant represents the third cost element used in the execution of the maintenance and improvement work. The analysis of the plant variances should be the same as the analysis of labour variances previously described. A comparison between the budgeted and actual cost of the County Council owned plant and hired plant should be carried out separately. The price variance should reflect the difference between

C T HORNGREN. Op.cit., p. 165.

J G BLOCKER & W K WELTMER "Cost Accounting" third edition (London, McGraw-Hill Book Co. Inc., 1954) as cited by R I DICKEY Op.cit., p. 17.12.

the pre-determined rate per day or hour for using the item of plant, and the actual rate which may increase or decrease causing a favourable or unfavourable variance. The efficiency rate should represent the variance between the programmed working days or hours, and the actual time spent in carrying out the actual work.

d) Expense variances

The expense variances should be calculated for the fixed cost elements which occur in the cost centres. A comparison between the budgeted and actual expenses should take place to report favourable or unfavourable variances to the manager responsible for the cost centre. This type of variance analysis should be on a monetary basis only.

e) Overhead variances

The service cost centres allocate their variable materials costs and expenses to the plant cost centres, or to the work carried out by outside parties. These costs represent the amount of costs that should be absorbed by the work at the predetermined level of activity. An unfavourable variance should represent the cost of idle capacity, which should be analysed to discover the cause of this variance, the only way to do this is to investigate the possible causes, item by item. However, it is convenient to separate the overheads incurred applied to the work, into fixed and variable components. The variances for fixed and variable overheads may then be computed individually. As a result of this, the following analysis can be carried out, for variable overheads:-

Efficiency variance =

(Programmed hours - Actual hours) x Variable overhead rate

Budget variance =

(Actual hours x variable rate) - (Actual variable overheads) and, for fixed overhead variances:

Budget variance = Actual fixed costs - budgeted fixed cost.

H BIERMAN, Jr & A R DREBIN, op. cit., p. 109.

Idle capacity variance =

(budgeted hours - actual hours) \mathbf{x} fixed overhead rate

Efficiency variance =

(programmed hours - actual hours) x fixed overhead rate

The variable overhead efficiency variance is the amount of variable overhead caused by working a different number of hours from the programmed. The variable budget variance, is the difference between the overhead cost that should have been incurred, and the amount that was incurred for the actual hours that were worked - (assuming that a flexible budget is used). The idle capacity variance arises when the actual hours worked differ from the number of hours used for calculating the fixed overhead rate. (46)

The above analysis necessitates that the rate of allocating overhead should be divided into its components - fixed and variable costs - to permit such analysis, but it should be noticed that these rates should be used for variance analysis only and not for allocating overhead to the work carried out in the service cost centres.

Figure 9.1, presents the type of variance analysis which should be included in the cost units and cost centres reports.

The framework of the variance reports

The variance reports should be prepared by the control offices in the divisions in respect of the maintenance operations, the control office in the central repair depot in connection with the repair work in the workshops, and the control section in head office in respect of the improvement works.

In doing so, the control offices and control section depend on the following data to prepare the variance reports:

the cost accounting data which is calculated in the cost accounting records representing the actual cost of the work executed in the department;

^{46 &}lt;u>Ibid</u>. p. 110.

The central laboratory is not included in the suggested system, but if it is included in the department structure, its control office should prepare its variances reports in the same manner as the central repair depot control office.

Type of Variances Cost Unit and Cost Centre Reports	Material	Labour	Plant	Expenses	Overheads
Cost Units "Maintenance and Improvement Operations	Х	Х	X		
Plant Cost Centres	X			Х	
Administration Cost Centres				X	
Service Cost Centres		Х		Х	Х

Figure 9.1

The relationship between cost units and cost centres reports $\frac{\text{and}}{\text{variance analysis}}$

- 2. the approved budget and programme of work for the executed cost units - maintenance and improvement operation -, the plant cost centres budgets and programme of work, and the service cost centre budgets for the reported period;
- 3. the achievement and performance reports for all the measured work in the department which should be prepared by the workstudy section and offices according to their responsibilities;
- 4. the results of the materials analysis compared with the predetermined specifications included in the cost units tender.

Variance reports should be prepared to report all variances, whatever the size of variance is, as a small percentage of variances in the present period may lead to and/or accumulate to a big percentage by the end of the operation; specially when the budget and programme of work are assumed to be prepared after taking all the uncontrollable causes of variances into account. The decision chart presented by BIERMAN, FOURAKE, and JADICKE, (48) seems to be difficult to use with the analysis of cost unit variances in the Highways Department, as it necessitates the preparation of a separate chart for each cost element required for each operation. This is because of the unsimilarity of the circumstances surrounding each operation, and would probably lead to difficulties in practice. On the other hand, the use of the decision chart may be useful in deciding whether to "investigate" or "not to investigate" the reasons for expenses variances.

The preparation of the variance reports are the responsibility of the control offices and control section in the Highways Department which may prepare the reports manually or by the use of computer. The variances between the actual and the budgeted costs should be reported in these types of reports against the appropriate cost units, cost centres, and cost element codes. In other words the same codes used in calculating the actual and determined costs should be used in the variance reports.

⁴⁸ H BIERMAN, L E FOURKER & R K JADICKE op. cit., pp. 409-417.

The suggested framework (49) of the variance reports which should be prepared in the Highways Department; classified into the level of management receiving the reports, the frequency of reports and the main characteristics of each report, is as follows:

The suggested framework represents the essential reports which should be presented to each level of management, and it is possible to add another type of report to the different levels of management when required.

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QUARTERLY REPORTS	2. THE ADMINSTRATION COSTS VARIANCES REPORT. The report covers the total department administration cost variances.	4. The administration costs variances report. This report should show the variances of each location of the administration cost centres throughout the Highways Department.
MONTHLY REPORTS	1. THE MAINTENANCE AND IMPROVEMENT WORK VARIANCE REPORT. The report includes the cost variances on maintenance and improvement work classified into the type of roads for the county roads.	3. The maintenance and improvement work variances report. This report should include the same information as in the county surveyors report with more details about the location of roads, and the major improvement projects.
WEEKLY REPORTS		
REPORT REQUENCY MANAGEMENT LEVEL	THE COUNTY SURVEYOR	THE DEPUTY COUNTY SURVEYOR

THE HEAD OF THE MAINTENANCE ORGANISATION	ment work variances report. The report should cover the total cost variances of the maintenance and improvement work executed in each division classified into the type of roads. The major improvement work should be included as a separate item in the report.	ADMINISTRATION COST CENTRES VARIANCES REPORT. This report should only cover the variances in the maintenance organisation administration cost centres.
	Summary of the plant utilization report. Summary of the plant utilization variances in the central repair depot and on sites should be included in this report.	
	7. Progress report. Reporting the variances between the approved programme of work and the actual achievement for the maintenance and improvement work in each division.	

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11. THE ADMINISTRATION COST CENTRE VARIANCES REPORT. Covering the administration variances of the head office sections. 12. THE MAINTENANCE ORGANISA- TION ADMINISTRATION VARIANCES REPORT. A copy of the report presented to the head of the maintenance organisa- tion.	17. THE ADMINISTRATION COST CENTRE VARIANCE REPORT. The divisional administration cost variances should be reported in detail in this report.
9. THE MAINENANCE AND IMPROVE-MENT WORK VARIANCES REPORT. A copy of the report presented to the head of the maintenance organisation. 10. MONTHLY EXPENDITURE VARIANCE REPORT. Covering the variance between the monthly actual expenditure and the budgeted expenditure.	14. The maintenance work variance report. The report should cover the variances between the actual performance and costs, and the adjusted budgets of the cost units. The report should show the gang responsible for such variances and the duration of each operation. 15. The improvement work variance report. It should cover the same information as the maintenance work variance report using the appropriate cost unit code number.
•	13. Service cost centre variance report. Reporting the idle capacity of the workshops; see report presented to the deputy plant engineer.
THE HEAD OF THE ADMINISTRATION DEPARTMENT	THE DIVISIONAL MANAGERS

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rk in-	plant or all the central repair depot tin services cost centres, sites and the divisional work- lant the fitters idle capacity costs - which are not allocated to a job - and the overhead variances for the original and adjusted service cost centres budgets. The changes in the allocated rate per hour should also be included in this report for each service cost centre.
16. Progress report. Covering the variances between the achieved work and the programme of maintenance and improvement work in the division.	18. Covering in detail the plant utilization variances for all the County Council plant in the central repair depot, the divisions depot and on sites according to approved plant cost centre programme of work.
THE DIVISIONAL MANAGERS	THE PLANT ENGINEER MANAGER OF THE CENTRAL REPAIR DEPOT

20. The plant cost centres variances reports. This should report the variances in the total running costs for each plant cost centre and the changes in the charged rate. 21. The central repair depot administration costs variances. The report should include the same type of information reported to the divisional managers.	Progress report. Reporting the variance between the divisional approved programme of work and the achieved work.
	COST VARIANCES REPORT The report should cover the detailed analysis of approved price variances, usage and price variances for each operation. The report should include information about the gang which carried out the work, and the performance variances. A separate report should be prepared for each cost unit and the number of reports present-
THE PLANT ENGINEER MANAGER OF THE CENTRAL REPAIR DEPOY cont.	THE DIVISIONAL MAINTENANCE AND CONSTRUCTION ENGINEERS

THE DIVISIONAL MAINTENANCE AND CONSTRUCTION ENGINEERS Cont.	22. cont. should depend on the number of operations taking place in each division.	
THE DEPUTY PLANT ENGINEER	24. Service cost centres idle capacity. This covers the cost of idle capacity in each service cost centre. The unallocated fitters' costs and working hours, should be included in this report which should be prepared for each service cost centre separately.	25. Service cost centres overhead variances reports. A detailed analysis of the fixed and variable overhead variances should be includ- ed in this report, and the changes in the rate of allocating overheads should also be included. A separate report should be prepared for each service cost centre. 26. Plant cost centre variance report. A separate report for each plant cost centre covering in details the variances of the running costs - usage and price variances - and the changes in the charged daily rate.

28. PROGRESS REPORT For the construction and surfacing programme of work.	29. PROGRESS REPORT. A copy of all the progress reports presented to the divisional and head office engineers.	30. MATERIALS PRICE VARIANCE REPORT. Covering the price variances of all types of materials purchased during the reports duration.
EEPORT. The same type of report as presented to the divisional engineers, concerning the variance analysis of the major construction projects and the surfacing operations carried out in the county.		
THE HEAD OFFICE CONSTRUCTION AND SURFACING ENGINEER	THE HEAD OFFICE WORKS ENGINEER	HEAD OF THE PURCHASING AND STORES SECTION.

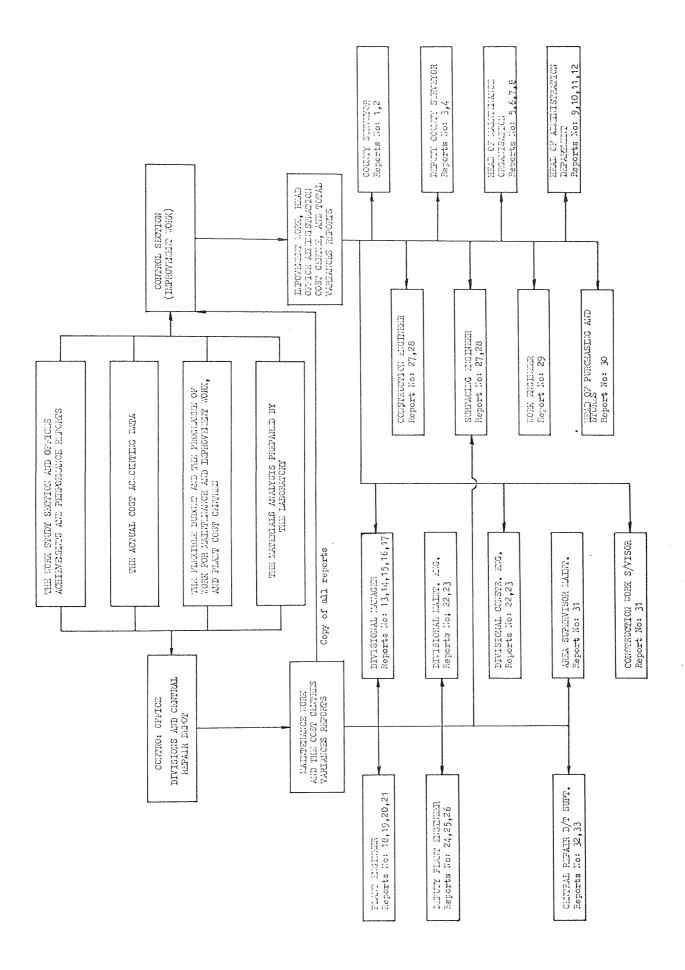
	33. SERVICE COST CENTRE VARIANCE REPORT. Covering the quantitive variances of the variable overhead only.
31. COST UNIT REPORT. Covering quantitative variances of materials, labour and plant used in carrying out the operation. A separate report should be prepared for each operation. The report should show the variance of labour cost caused by the use of workers with the wrong rate for a specific operation.	32. SERVICE COST CENTRE IDLE CAPACITY REPORT. Reporting the number of idle hours in each service cost centre.
THE DIVISIONAL MAINTENANCE AND IMPROVEMENT SUPERVISORS	THE CENTRAL REPAIR DEPOT SUPERINTENDENT

The responsibility for preparing these reports is shown diagrammatically in Figure 9.2. From this figure, it is clear that the control section - head office - is responsible for preparing: the variance report of the improvement work, the head office administration cost variances, and the total variances reports required for the top management. These should be prepared according to the section records and copies of the reports received from the control offices in the different locations of the department. The maintenance work variance reports and the cost centres variances reports, are the responsibility of the appropriate control office as explained in Chapter one (The Highways Department Organisation). The numbering of the reports, shown in the Figure 9.2 are as described in the description of the framework of the variances reports.

An example of the monthly report of the division maintenance and improvement operation variances is shown in Figure 9.3, which should be presented to the divisional manager, Figure 9.4 presents an example of the quarterly report of the service cost centres which should be presented to the plant engineer and Figure 9.5 presents the weekly cost unit reports which should be presented to the divisional supervisors. These figures are only examples of the variances reports, and it is up to each county to prepare its own reports without minimising the amount of information described in the framework of the variances reports.

2. The action reports

The action reports should be used in the Highways Department organisation only up to the level of divisional engineers, central repair depot deputy plant engineer, and the head office construction and surfacing engineers. The action reports should use the divisional supervisors and/or the central repair depot superintendents report form. They, after consulting the gangers, should report the cause of the reported variances and the corrective action taken to overcome it, on the back of their reports and present it as soon as possible to the engineer to whom the supervisor or superintendent is responsible. The engineer may accept the action taken to overcome the cause of variance or he may suggest a different action which should be written in the appropriate part of the back of the report and he should sign it before returning it to his subordinate.



FAG. 9.2 THE FRANCHORK OF THE SURGESTED VALLANCE REPORTS

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I NO:THE DIVISIONAL MANAGER:		LOCATION AND GANG ROAD NO. NO.	
DIVISION NO: NALE OF THE	-	COST LO COLE NO.	

MONTHLY PEPORT OF THE DIVISIONS MAINTENANCE AND IMPROVENEUR OPERATIONS VARIANCES

Service Cost Lescription: Presented to Control Code To. 511 Tair 512 Engr 514 Eog 515 Tyr 515 Tyr 515 Tyr	Service Cost Centres Sub Code No: Escription: Presented to Lir	Budgeted Costs -	Absorbed Cost Actual Cost	A A A	Promise Parise P	P	and the state of t	月 号 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Margeted Cost Section 1	Adjusted Dudgeted Cost Original Dudgeted Cost Os Idle Capacity Capacity	9 : Budgeted Cost	Actual Cost	Absorbed Cost	Pron original Budget 4 - 5	Varia Rrom adjum Budgo 5 - 6	t ted	Under or over absorption 6 - 7 %	St. pi di	Ente Beginning of period Ente Criginal Ente Under or over absorption > From adjusted Budget > From original Budget > Fro	inder or over absorption is absorption in the interest of the	period Ente Criginal Rate	beginning of period Eate	Hext period into
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Fig. 9.4 Quarterly Report of the Service Cost Centres Variances

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Fig. 9.5

3. The graph reports

The use of graphs in the divisions should be limited to the use of the programming charts - Figures 7.11 and A8.6 - and the plant cost centres utilization charts - Figure 8.3.

The deputy county surveyor, the head of the maintenance organisation and the head of the administration department may use the traditional form of the S curve chart (50) in order to compare between the budgeted, adjusted and actual expenditure of the Highways Department.

4. The informational reports

Informational reports should be used when required to present information to the different levels of management about the changes in the programme of work, the total costs of an improvement project, etc... There is no predetermined form of this type of report as it should be prepared to suit the situation necessitating its preparation.

This curve chart draws its name from the fact that the cumulative budgeted expenditure takes its shape as that of a letter S, even if it is a rather flat form of that letter.

CHAPTER 10

THE FLOW OF DOCUMENTS IN THE HIGHWAYS DEPARTMENT

In the previous chapters the suggested structure, codes, records, budgets, and reports of the Highways Department have been described. In this chapter, the relationship between, the prime documents (1), records, budgets, and reports will be described according to the responsibilities of each office and section stated in the description of the departmental structure.

The flow of documents has been designed on the assumption that the information system will be computerized, and, if it is not, extra copies of the prime documents are needed to be kept in the appropriate offices and sections for recording the information manually. The flow of documents has also been designed with the requirement of internal control in mind, this to ensure that all information has been audited before being put into records.

1. Materials Flows of Documents

The materials flows of documents covers the procedures for recording and reporting the cost of materials delivered to stores and then issued to the appropriate operations, or service cost centres, and materials delivered directly to sites.

1.1 Materials delivered to stores

This flow of documents, covers all the materials delivered to the Highways Department stores. The suggested flow for this type of materials is the following:-

The design of the prime document will not be included in this research and it is up to the Highways Departments to design their document taking into consideration that the document should include all the information requirements of the coding system, cost records, budgets, and reports previously described.

- (1) The control section should pass the materials budget and programme of work to the computer section, purchasing and stores sections, and the appropriate programme of work to the purchase and stores offices.
- (2) The purchase section should invite tenders from the suppliers for the whole of the quantities of materials needed for the department. A list of accepted tenders should then be sent to the purchase and stores offices in the different locations and to the accounting section head office.
- (3) The purchase offices should calculate the maximum, the minimum and the re-ordering points of stock, and issue a 'purchase order' (original and 3 copies) when arriving at the reorder point. The original and copies of the 'purchase order' should be distributed as follows: The original to the supplier, a copy to the store keeper, and a copy to the accounting section. The last copy should be kept in the purchase office.
- (4) The supplier will deliver the materials to stores. The store keeper should accept the material according to the copy of the 'purchase order' and prepare a 'goods received note' (original and 1 copy); he should keep the copy and record the received materials on the appropriate stock cards (quantities only); the original should be forwarded to the purchase office. In this office, the 'goods received note' should all be checked against the 'purchase order' copy, priced and coded according to the cost element code before passing it to the accounting section.
- (5) The accounting section should receive the supplier invoice, check it against the accepted tenders, the copy of the 'purchase order', and the 'goods received note', before preparing the weekly schedule of payments, which should be forwarded with the 'goods received note' to the computer section as an input.

The print out of the computer, which may be an accounting record or variance and/or informational report, should be distributed to the appropriate sections and offices in the following manner:-

- (1) The weekly supplier ledger to the accounting section with the invoices for filing.
- (2) The weekly stock control record updated with the new balance and price, - the result of receiving and issuing materials from stores - accompanied by the 'goods received note' for filing.
- (3) The cheque to the suppliers.
- (4) The monthly materials variance report to the head of the purchase and store section.
- (5) A copy of the monthly materials report to the control section.

Figure 10.1, represents a diagrammatic figure of this flow of documents.

1.2 Materials issued from stores

This flow of documents should be used for materials issued to the cost units and materials issued to the divisional or central repair depot service cost centre and plant cost centres. The forms used for issuing materials and the procedures, should be the same in all the Highways Department locations. The following is the suggested flow of documents for materials issued for maintenance and improvement operations.

- (1) The control section and offices should ensure that a copy of the operational budget and programme of work is sent to the computer section and the purchasing office and section, and the programme of work only to the cost accounting section and offices.
- (2) The ganger gang foreman should complete a 'requisition note' (original to the store-keeper as a receipt for the requested materials, and send a copy to the appropriate cost accounting offices of section; the area supervisor may substitute for the ganger.)

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- (3) The store keeper should deliver the materials, and should keep the 'requisition note' and complete an 'issue note' (original and 1 copy). He should then pass the original to the purchase office and keep the copy for recording in his stock cards. (Both the 'requisition note' and 'issue note' may be integrated into one form and, in this case, it should be from an original and 2 copies; one to be sent to the cost accounting section or offices, and the second to be kept with the store-keeper).
- (4) The purchase office should price and code the issued materials recorded in the 'issue note', and then pass it to the appropriate cost accounting offices or section.
- (5) The cost accounting office or section should check the 'issue note' against the copy of the 'requisition note', and allocate the code and the 'issue note' to the appropriate operation before forwarding it to the computer section as an input.

The print out of the computer should be as follows:

- (1) The materials records for the maintenance operation, which should be sent to the divisional cost accounting offices, and the materials records for the improvement operation to be sent to the cost accounting section.
- (2) The stock control records up-dated by the issued quantities and prices accompanied by the 'issue note', to be sent to the appropriate purchasing offices and section for filing.
- (3) The materials quantitative variances, which should be included in the cost unit weekly report presented to the supervisors and the cost unit report presented to the divisional and head office engineers.
- (4) Copies of the variance reports to the appropriate control offices and sections.

The suggested flow is shown diagrammatically in Figure 10.2; note that the cost unit reports presented to the divisional and head office engineers are not included in the figure.

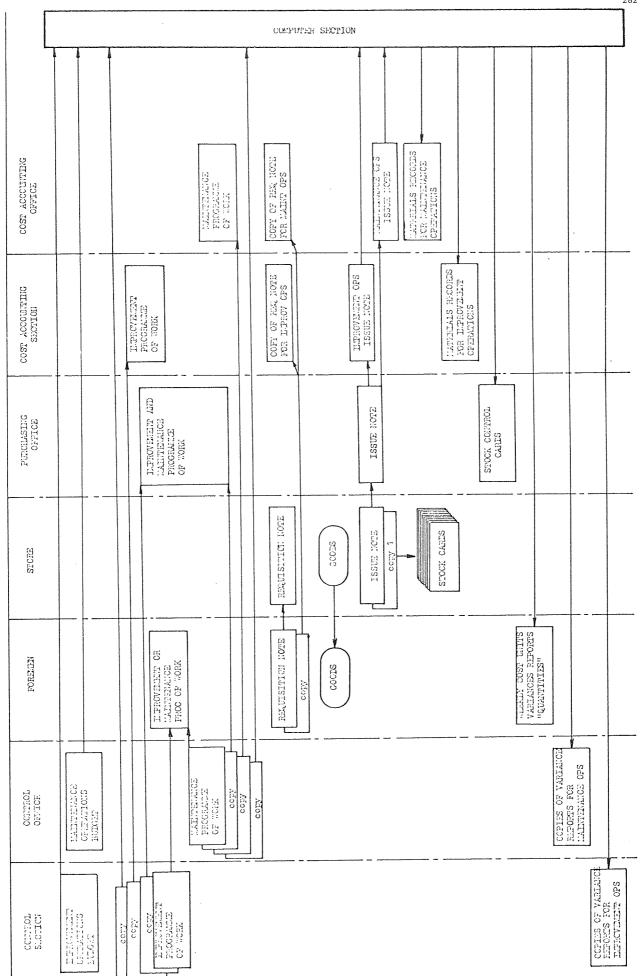


Fig. 10,2 THE FLOW OF DOCKMENTS FOR MATERIALS ISSUED FROM STORES

In the central repair depot, the above procedures should be followed except for the following changes:

- (1) The central repair depot superintendents and the workshop foremen should replace the divisional supervisors and the gangers.
- (2) The depot cost accounting office should check the 'issue note' and 'requisition note' against each other and also against the 'job orders' Figure 4.2 for spare parts issued from the depot stores. This is to ensure that the cost of these materials has been allocated to the appropriate plant cost centre and/or outside parties 'job orders' in order to include it in their invoices.

1.3 Materials delivered to sites

This flow of documents covers the purchasing and delivering procedures. The procedures of purchasing materials differs from those for materials delivered to stores in the following:-

- (1) The 'purchase order' should be prepared to cover all the quantities of materials required for the operation.
- (2) The daily quantities delivered to sites should be determined by the ganger and area supervisor or construction supervisor, who should report it daily to the purchase office to order it from the supplier.
- (3) A 'copy' of the 'purchase order' should be sent to the ganger to accept the materials delivered by the supplier, according to the contents of the form; this copy is the one which should be sent to the store-keeper when delivering materials to stores.
- (4) The ganger should pass all the 'delivery notes' to the purchase office which should prepare a priced and coded 'return of materials received note' (original and 1 copy). The office should keep the copy and send the original to the appropriate cost accounting office to allocate the costs to the appropriate operation and check it against the operation programme of work

before sending it to the accounting section for checking and include the invoice in the schedule of payment, and then sending them together with the 'return of materials received note' to the computer as an input.

The print out of the computer in this flow of documents should be the same as the out-put of the previously mentioned flow of documents for materials delivered and issued from the stores. The suggested flow is shown diagrammatically in Figure 10.3.

1.4 Haulage

The materials which are delivered to sites may be delivered by the suppliers' lorries, hired lorries, and/or the County Council lorries. The cost of haulage when using the suppliers' lorries should be included in his invoice, and should be dealt with at the same time as when dealing with the cost of materials, taking into consideration that the haulage cost should be coded and recorded separately onto the materials records. On the other hand, when using hired or County Council lorries to deliver materials to sites, the cost of haulage should be accounted for through 'the daily haulage report' prepared by the lorry driver and should show, the time of trips, number of miles, weight and description of materials hauled, its route and the destination. The form should be signed by the driver, and approved by the appropriate supervisor before being forwarded to the divisional cost accounting office for recording the haulage rate per mile, and for calculating and allocating the total cost of haulage for each journey included on the form. The cost unit code number of the maintenance operations should be entered before passing the form to the cost accounting section for checking and entering the code number of the improvement operations included on the form. All reports should then be forwarded to the computer section as an input.

The print out of this flow should be the cost of haulage, included on the materials records or a separate haulage record, which should also be sent to the appropriate cost accounting section or offices.

2. The Labour Flows of Documents

There are two types of workers in the Highways Department, the first is the road men who are carrying out the improvement and maintenance operations on sites, and second, are those workers working in the

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Fig. 10.3 THE FLOW OF DOCUMENTS FOR LARBILALS DELIVERED TO SITES

VASTATOSS VASTATOSS REFORMS divisional depot or the central repair depot services cost centres. Each of these categories requires a different prime document and, therefore, the flow of documents differ.

2.1 The flow of documents for roadmen

This flow assumes that the operational and programme budgets are distributed by the control offices and section, as described in the materials flow previously mentioned.

The roadmen should complete the weekly 'time sheet', daily, showing the actual hours spent on each job. It should be signed by the worker and approved by the ganger before being forwarded to the divisional accounting office. In that office the sheet will be checked for errors before being dealt with as follows:-

- (1) Improvement gangs 'time sheet' sent to the cost accounting section for coding and allocation of hours to the appropriate operations.
- (2) Maintenance gangs 'time sheet' sent to the divisional cost accounting office for the same purpose as in (1).

All sheets then go to the computer section as an input. The foreman should prepare a weekly 'work sheet' which covers information about the size of the gang, type and source of plant on site, and a brief description of the measured and unmeasured work. This information should be used for calculating the workers' bonus payment. The gang 'work sheet' should be forwarded to the workstudy office or section, for checking and calculation of the pay performance of the gang, before being passed to the computer section as the second input. (The idea of integrating the 'time sheet' and 'the work sheet' in one form has been examined and rejected as a result of the importance of the time factor which is required for checking the content of both sheets before sending them to the computer sections).

The print out of the computer should be as follows:-

(1) The pay slips which indicate the total and net payment for each worker. These should be sent to the cashier for payment

or sent directly to the worker with a cheque for the net payment.

- (2) The labour cost records for the operations executed should be sent to the appropriate divisional cost accounting offices and the cost accounting section.
- (3) The wages ledger, should be sent to the accounting section and accounting offices accompanied by the time sheets' and the 'work sheets' for filing.
- (4) The labour efficiency variances, and the cost of using workers with different wage rates for specific operations, should be included in the weekly cost units reports presented to the supervisors.
- (5) A weekly detailed cost unit report should be sent to the appropriate head office and divisional engineers.
- (6) A copy of all reports to be sent to the appropriate cost accounting office and section.

Figure 10.4 represents a diagrammatical figure of this flow of documents, note that the reports described in (6) are not included in the figure.

2.2 The flow of documents for the central repair depot fitters

The nature of the fitters' work differs from that of the roadmen; the fitters either work in the central repair depot, or may be sent to carry out repairs on sites, but, in both cases, they should report daily to the central repair depot premises, and record their arrival and departure times on their 'time card'. This card should be sent weekly to the divisional accounting office for the preparation of the 'wages sheets', which should include the total number of the weekly attendance hours and the gross and net wages, according to these 'time cards'. The office should then keep the 'time cards' and send the 'wages sheets' to the computer as an in-put.

The out-put of the computer in this case should include:

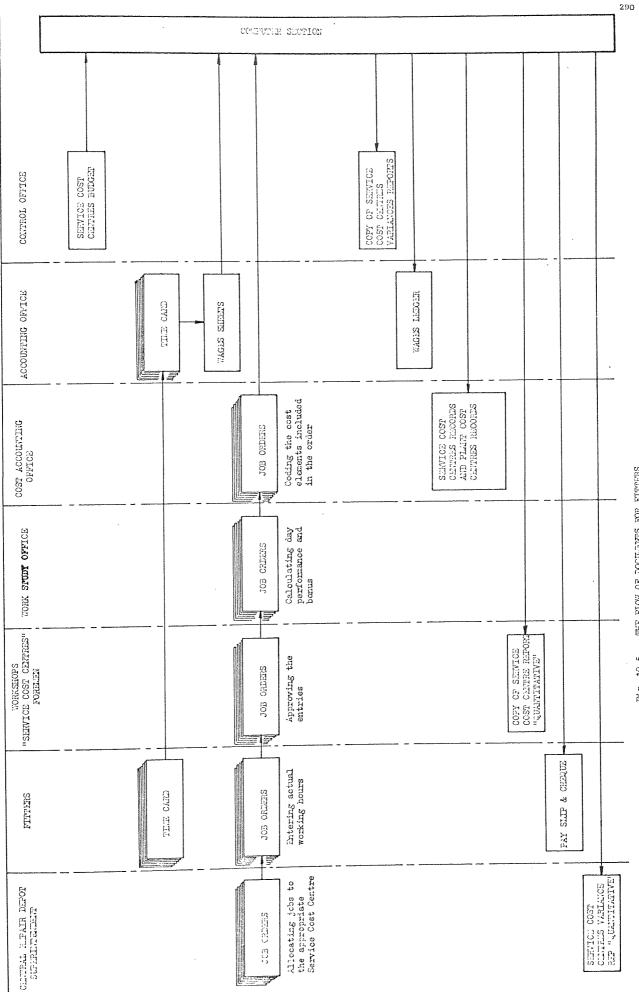
Fig. 10.4 THE FLOW OF DOCUMENTS FOR ROLINEX

- (1) The wages ledger, which should be presented to the accounting office.
- (2) The fitters wages, which should be recorded in the service cost centre records and the appropriate plant cost centres records as described in Chapter four, and should be presented weekly to the cost accounting office.
- (3) The labour efficiency variances, which should be included in the services cost centre weekly report and should be presented to the centre foreman and to the central repair depot superintendent.
- (4) The labour rate and efficiency variances, which should be included in the weekly reports presented to the deputy plant engineer for all services cost centres.
- (5) The pay slip and cheque for net payment, which should be sent to each fitter.
- (6) A copy of the variance reports, which should be sent to the control office.

A diagrammatical figure of this flow of documents is shown in Figure 10.5, note that the reports described in (4) are not included in the figure.

3. Plant Flow of Documents

The cost of plant allocated to the operations — cost units — should be calculated according to the actual time spent on the operation site. This should be reported by the lorry driver or plant operator in a 'weekly plant return'; in this form the driver or operator should record the working and idle hours spent on site for each operation executed during the week. Instructions about these locations should be sent to the driver or the plant operator at the beginning of each week by the control office according to the plant cost centre programme of work, which should be prepared from the approved programme of work of the maintenance and improvement operations. The 'weekly plant return' form should include all information required for recording in the cost units plant record described in Chapter four. After preparing this form, the gang foreman should approve it before forwarding it to the division cost



THE FLOW OF DOCULEATS FOR FITTING Fig. 10.5

accounting office. If the plant was used for maintenance operations, this office should allocate and code the form according to the cost unit, cost centre, and cost element codes, and, if the form includes work carried out for an improvement operation, the form should be forwarded to the cost section for the same procedures before sending it to the computer section as an in-put. On the other hand, if the form deals only with improvement operations, it should be sent to cost accounting section, to allocate and code its components, and then to the computer section as an in-put.

The amount of work carried out by the plant should be included in the gang foremans 'work sheet', previously mentioned in regard to the roadmans' flow of documents, and should be dealt with in the work study section and sent to the computer section as an input.

The out-put of the computer in this case should be:-

- (1) Recording the allocated plant charges in the plant cost centre record, which should be sent to the central repair depot cost accounting office.
- (2) The improvement and maintenance operations plant cost records which should be sent to the appropriate cost accounting offices or section.
- (3) The plant efficiency variances, which should be included in the gang foremens' weekly cost unit variance reports, and copies of the gangs' weekly reports should be sent to the appropriate supervisor.
- (4) The efficiency and rate variances, which should be included in the weekly cost unit reports presented to the divisional or head office engineers.
- (5) Copies of all variance reports, which should be sent to the appropriate control offices and sections.

Figure 10.6 represents a diagrammatical figure of the plant flow of documents; note that variances reports described in (4) are not included in the figure.

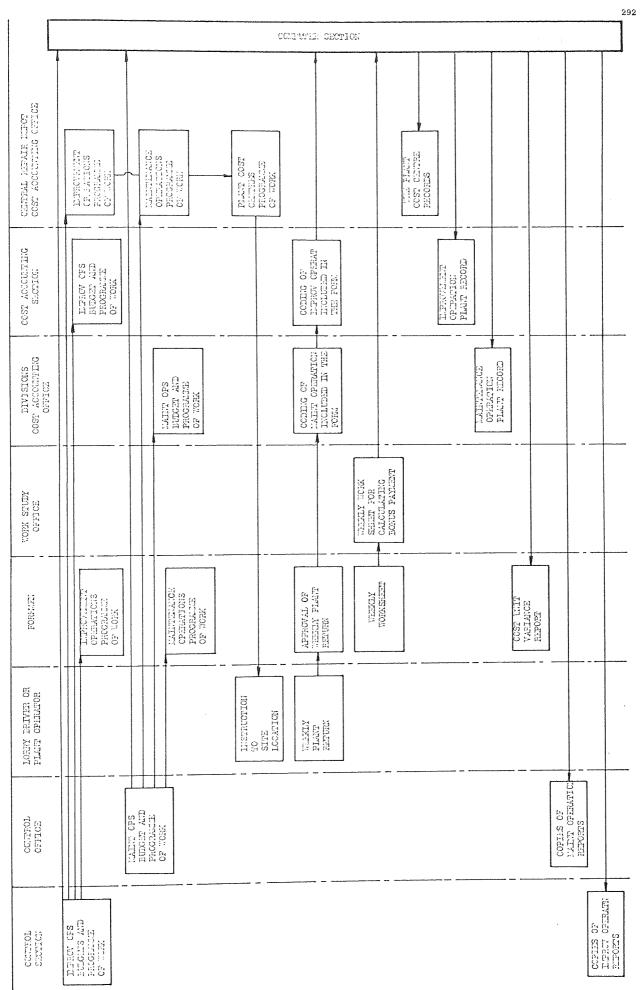


Fig. 10.6 PLAIT FLOW OF DOCUMENTS

The above flow covers the County Councils own plant. The procedures described in this flow should be changed to suit the hired plant. These changes are as follows:-

- (1) The computer input. The hiring company should present an invoice to the appropriate cost accounting office, or section, to check it against the 'weekly plant return' before passing it to the accounting section for checking against the approved annual tender and scheduling it for payment.
- (2) The out-put of the computer.
 - 1. A cheque to the hiring company should be prepared.
 - 2. The creditors' ledger should be sent to the accounting section.

The plant cost centres records should hot be involved.

4. The Contractors' Work Flow of Documents

All the contractors' payments should be paid according to the finished work which should be included in the 'engineers certificate'. This certificate should be sent to the cost accounting offices or section for coding the work included in the form and to check it against the accepted tender before forwarding it to the accounting section to schedule the net value of the work included in the certificate; this should be calculated according to the conditions included in the tender, and the schedule of payment and the 'engineers certificate' should be presented to the computer as in put.

. The out put of computer should be:-

- (1) The contractors ledger, which should be sent to the accounting section after recording the total value of work and the net payment.
- (2) The contract work cost record, which should be presented to the appropriate cost accounting offices or section.
- (3) An informational report about the progress and total costs of the finished work, which should be presented to the divisional and/or the head office engineers.

5. The Expenses Flow of Documents

This flow covers all the fixed costs and the variable expenses which may occur during the year. This type of expense covers materials, employees cost, and other expenses. The prime document for each of these expenses should be sent to the appropriate costs accounting office or section for coding before the accounting section schedules its value for payment. The prime document should then be sent to the computer section accompanied by the schedule of payment as in put.

The out put of the computer should be:

- (1) The appropriate accounting ledgers, which should be sent to the accounting section.
- (2) The administration cost centre records, which should be sent to appropriate cost accounting offices and sections.
- (3) The quarterly administration variances reports, which should include the appropriate information required for the different levels of management as described in Chapter nine.

BUDGETING, BUDGETARY CONTROL AND MANAGEMENT INFORMATION IN HIGHWAYS DEPARTMENTS

SUMMARY AND RECOMMENDATIONS

It is the intention of this research to design a practical management information system built upon a theoretical base for the Highways

Departments in the United Kingdom, which will provide all levels of management with information which will help them in decision making, controlling costs, and secure the full utilization of the departmental resources. Accordingly, the existing organisation structure of those Highways Departments covered by the questionnaire have been examined; the report presented by the Transport and Road Research

Laboratory on the Highways Authority Organisation has been used as the basis for a complete organisation structure based on the line, functional staff, and committee type of organisation. This organisation structure has clear and simple lines of authority, responsibilities, accountability and clear channels of communication.

The existing cost accounting theories have been examined to choose the most appropriate costing theory to be the basis of the information system; this is proved to be the marginal costing theory. This means that the cost units and production cost centres should be charged with the variable cost only.

On the other hand, the use of absorption costing theory has been recommended when pricing the outside parties works carried out by the Highways Department.

The traditional method of treating construction jobs as the cost units of the enterprise, which does not enable management to have the appropriate information required for cost control, has been substituted by breaking down the work carried out by the Highways Department into a number of operations. Accordingly a large project may consist of all

these operations or only some of them. The cost units which represent these operations, have been identified and defined in the same manner as the actual operations; the maintenance operations according to "Marshall report" recommendations, and the improvement operations according to the methods of measurement for road and bridge works.

The cost centres have been classified into production cost centres - plant cost centres; which cover the county councils own plant, the administration cost centres; covering the administration offices in the different locations of the county, and the service cost centres; which cover the workshops and laboratories in the different locations of the Highways Department. The cost elements which are usually in use in the Highways Departments have been identified and classified into variable and fixed costs according to the "cost variation with volume" postulate. The different coding methods have been examined, and the group method of coding has been used for coding the cost unit, the cost centres, and the cost element; a comprehensive cost units, cost centres, and the cost elements codeshave been illustrated in Appendix 2 and 3.

The cost accounting records for the cost units, and the cost centres which are based on the suggested codes, have been described in detail. Each of these cost records has been designed to include all types of information which might be needed to ensure overall control over the cost elements and the quantitative aspects, and also to present information needed for the different purposes of decision making.

A theoretical survey of budgeting and budgetary control and their application in the Highways Department covers the historical development of budgeting, budgeting and budgetary control definitions, the planning and controlling function of budgetary control, the budget period, types of budgets, and the advantage and limitation of budgeting in the construction industry has been carried out, and in the light of this survey, the existing Highways Departments have been examined, and they are seen to be governmental type of budgets which do not help management in the day-to-day decision making. As a result the budgeting system has been

suggested covering the capital budget, the cost unit budgets, and the cost centre budgets on a flexible basis; it also covers the framework of establishing and distributing the Highways Department budget.

The Highways Department capital expenditure budget has been divided into: first, the improvement projects capital expenditure budget which represents projects financed by grants or loans. The work in this part has been limited to the description of the cost benefit analysis method known as COBA introduced by the Department of the Environment, which is recommended to be used in choosing between different improvement projects competing for limited available resources in the annual capital expenditure budget. Secondly, the plant capital expenditure budget; the study covered three important factors which are required for preparing the plant capital budget, these factors are (1) the economic life of plant; (2) the optimum size of plant fleet which should be owned by the county council, and (3) the allocation of the available funds between different alternatives.

The traditional thought of the Bill of Quantities as the construction work budget has been examined and proved to be limited to obtaining tenders and valuation of the work executed; work is now going on elsewhere to improve the existing Bill of Quantities and this should improve the situation - it does not relate to the programme of work and this affects the accuracy of the variance reports, and will not permit the detailed analysis of variances. A flexible operational budget which covers in detail the cost elements components has been introduced. This budget has been related to a programme of work; for the improvement operation a study of PERT and CPM has been carried out in order to choose the basis for programming the improvement projects, and it has been concluded that CPM is the best method for planning the programme of work for the improvement work carried out by the Highways Department direct On the other hand, it has been suggested that the maintenance labour. operations, which have smaller duration, should be programmed for by the use of a simple bar chart prepared for each maintenance gang. unit flexible budget should be prepared according to these programmes of work and this overcomes the limitation of the use of budgeting in the

construction industry. The cost unit, and cost element codes have been used in preparing the cost elements schedules and the operation budget. An example of the preparation of the programme of work for an improvement project has been illustrated in Appendix 8, also quantitative examples which might be used in determining the type and number of items of plant to be used for each operation are illustrated in Appendix 9. Another example of the procedures required to prepare one of the operational budgets of an improvement project has been described in Appendix 10.

The plant cost centres budget, deals with the estimate of (1) the plant capital cost, which covers plant depreciation and the rate of interest on capital; the different methods of calculating the annual depreciation and their effect on the annual interest, and the total cost have been examined, and it is proved that the annual cost method based on an adjusted rate of interest for the whole county is best; (2) the plant running costs, which should be prepared through the use of the "plant running cost estimate" form. The plant cost centres budget should enable the control office to calculate the daily rate per day for ordinary and idle time which should be allocated to the operations. The plant cost centre programme of work should be prepared according to the needs of the different operations which should be executed by the Highways Department and should ensure a full utilization of the county council owned plant; this has also been described.

The flexible budget for the service cost centres - workshops - which facilitates the calculation of the allocated rate per hour of the service cost centre cost to the plant cost centres has been described in detail.

The administration cost centes budget has also been described and the necessity for the use of absorption costing theory has been mentioned. The different methods of reapportionment have been examined to choose the most appropriate method to be used in reapportioning the administration costs to the outside parties work, and it is found that either the direct reapportionment method, or the step method should be used for calculating the predetermined rate for absorbing the service and administrative costs in the case of pricing work for outside parties carried out by the Highways Department.

The advantages of preparing a purchasing budget for the Highways Department have been discussed, and the procedures of preparing this budget have also been described in detail.

Reports represent the most important part of this system, therefore a theoretical survey of reports; covering the definition of reports, their function as media for control, the requirement of the "management by exception concept", the classification of reports, and the basic aspects of efficient reporting to the different levels of management, have been carried out. In the light of this survey, it has been suggested that the framework of the Highways Department reporting system should consist of variance reports, action reports, graphical reports, and informational reports. A comprehensive description of the suggested reporting system covering an introduction to variances analysis and its application in the Highways Department, the variance reports which should be presented to each level of management in the department, examples of some of these reports, and description of the action reports, graphic reports and the informational reports, have been included in this research.

The relationship between the prime documents, records, budgets, reports, and the different offices and sections of the Highways Department have been described in terms of the flow of documents for each cost element.

The suggested system may be introduced in three steps; the first step is to ensure that all the prime documents needed for recording information in the cost record contain all the required data; this can be achieved by examining the existing prime documents used in the Highways Department and adjusting, changing, may be cancelling the existing documents and/or preparing a new document if required. The second step is to replace the existing codes which are used in the Highways Department with the cost units, cost centres, and cost elements codes, and prepare the cost accounting records accordingly. The third step, is to introduce the operational budgets, and the cost centres budgets into the system; this should permit the preparation of the variances reports to be presented to the different levels of management. The period of time required to introduce each step should depend on the local

circumstances and the availability of the technical and administrative staff required to carry out the work required to benefit from this system.

The increase in the administrative staff required to carry out the system should not be noticeable especially after the reorganisation of local authorities, as the load of work in the county should be the basis for any additional staff, and it is believed that the existing administrative staff in the Highways Department can cope with the requirements of this system; the increase will be limited to the technical staff required for preparing the operational and cost centres budgets, staff required for the control offices and sections.

The cost of the suggested system is difficult to estimate in the absence of actual costs of the existing system in the Highways Department. But one can say that the use of the suggested system will increase the cost of the technical staff required for the control offices and sections; this can be limited to a rather small number of control offices serving the divisions. On the other hand, the cost of using the computer will be less than the cost of the existing system; this is due to the limited time required for the computer print-outs for the different levels of management, variance and informational reports only. If the actual figures show that the suggested system should cost more, this should be justified by the savings and efficiency improvements which this system should achieve and which come from many sources, such as the control of materials usage, the full utilization of plant in the central repair depot and on sites, and the availability of the information needed for decision making in the correct form and at the correct time.

The suggested information system should improve the administration capability, "Marshall report" states:

"The consultants suggest that by better administration alone the net savings available to authorities could amount to between 5 and 10% of the maintenance expenditure, in other words about £12m. We are not in a position to check this figure but the wide range of practices between authorities suggests to us that it is by no means unrealistic."(1)

Report of the Committee on Highway Maintenance. Op.cit., p. 54.

A SUMMARY OF THE RECOMMENTATIONS LISTED ACCORDING TO THE CHAPTER OF RESEARCH

- 1. The Highways Department, its organisation structure and information system. Chapter 1.
- 1.1 The Highways Department organisation structure is generally of the "line, functional staff, and committee organisation" type. From the examination of the various types of organisation structure, it seems that this is the best structure for use for Highways Department organisation.
- 1.2 There are problems which may occur as a result of introducing the suggested Highways Department organisation structure, but these should be solved by employing a better information system which should provide the different levels of management with information required for planning, controlling the work and in decision making.
- 2. Costing theories and information systems applicable to the Highways Department. Chapter 2.
- 2.1 The marginal costing theory should be the basis for the management information system for the Highways Department, but absorption costing theory should be the basis for calculating the charge for any work for outside parties.
- 3. The coding system for the Highways Department. Chapter 3.
- 3.1 The group method of coding should be the basis for the Highways Department coding system because of its advantages and suitability to cope with the department circumstances.
- 3.2 The existing numbers of the counties roads should be used for identifying each category of road.
- 3.3 The maintenance work should be classified into a number of cost units operations according to "Marshall Report" recommendations.
- 3.4 The improvement work should be classified into a number of cost units - operations - according to the method of measurement for road and bridge work.

- 3.5 The cost centres should be classified into plant cost centres, services cost centres, and administration cost centres.
- 3.6 The cost elements should be classified to variable and fixed costs according to the "cost variation with volume" postulate.
- 4. The cost accounting records for the Highways Department. Chapter 4.
- 4.1 A cost accounting record should be kept for each service cost centre in the different locations of the department. In the central repair depot and divisional service cost centres workshops the record should cover the cost of materials, fitters, and expenses, and also include the costs charged to the finished work which represents the recovered costs of the service cost centre.
- 4.2 The plant cost centre record which should be treated as a production cost centre should be kept for each cost centre, and should cover information about: the items of plant included in it, the cost and quantitities of materials, the cost of repairs in the central repair depot and/or outside garages, the allocated fixed cost covering road licences, insurance, and depreciation, and the allocated costs to the different cost units.
- 4.3 The administration cost centres records which consist of the administration materials and utilisation record, the employees cost record, the cost of communication cost record, general expenses record, offices equipment, furniture, and building costs cost record, labour fixed costs records, and the establishment and mobile plant records, should be kept in each administration cost centre for recording its administration cost.
- 4.4 A separate cost record should be kept for each cost element to be used for executing the operation (cost unit) the number of records which should be kept for each cost unit differ from one operation to another according to the operation nature.

- 5. Theoretical survey of budgeting and budgeting control and their application in the Highways Department. Chapter 5.
- 5.1 An annual budget on a flexible budget basis should be prepared to cover all the maintenance work budget, but the period for the improvement work budget should depend on the size of the project, and be prepared for the whole project regardless of the length of time. The information required for establishing the Highways Department budget should be sent to the control offices and section at least three months before the beginning of the financial year and a copy of the approved budget should be distributed to the different levels of management according to their requirements.
- 6. The Highway Department's capital budget. Chapter 6.
- 6.1 The COBA method should be used for choosing between different improvement schemes competing for limited available resources in the annual expenditure budget.
- 6.2 The plant capital expenditure budget should be prepared after considering the economic life of plant, the optimum size of plant fleet which should be owned by the County Council, and the priorities in allocating the available annual expenditure funds.
- 7. The cost unit budget and programme of work. Chapter 7.
- 7.1 The operational budget should be prepared through a separate estimate of the costs and quantities of each cost element and the Bill of Quantities should not be used as a substitution for this; it should be directly related to the programme of work.
- 7.2 The improvement projects programme of work should be prepared through the use of the critical path method.
- 7.3 A divisional improvement programme of work covering the estimated total cost, duration, required resources, and suggested starting day should be prepared for each division.
- 7.4 Maintenance work should be classified into routine, major, and emergency work, each requires a different programming procedure.

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- 8. The cost centres budgets in the Highways Department. Chapter 8.
 - 8.1 The plant cost centre budget should cover the plant capital cost which cover the annual depreciation and interest on capital calculated according to the "annual cost" method, and the plant running costs.
 - 8.2 The plant cost centre budget should be related to the programme of work to ensure maximum utilisation of the County Council plant.
 - 8.3 The service cost centres budget should be the basis for determining the service cost centre rate of overheads, and therefore, a separate budget should be prepared for each service cost centre.
 - 8.4 A separate estimate should be prepared for each section or office within the administration cost centre, and these estimates should be the basis for preparing the cost centre budget which should be accumulated to present the Highways Department annual administration budget.
 - 8.5 The work carried out by the Highways Department for the outside parties should be charged with the total cost of such work. This total cost should include a recovery of administration and service cost centres costs, calculated by using a predetermined rate of absorbing the costs, on the basis of the practical capacity in each cost centre multiplied by the actual capacity used in executing the work.
 - 8.6 The purchase budget should be related to the cost units programme of work in order to determine the economic quantities, the maximum inventory level, and the order level.
 - 9. The Highways Department reporting system. Chapter 9.
 - 9.1 The reporting system should be based on the "management by exception concept".
 - 9.2 The framework of the system should cover, variance reports, action reports, graphical reports, and informational reports.
 - 9.3 Variance reports should be presented to the different levels of management according to their responsibility and ability to take corrective action.

- 9.4 The use of the decision chart to determine "to investigate" or "not to investigate" the cause of variances should be limited to expenses variances only, and all other variances should be investigated as the budgets and programme of work are assumed to be prepared after taking all the uncontrollable causes into consideration.
- 9.5 The variance report should be sent to the different levels of management on a weekly, monthly, and/or quarterly basis.
- 9.6 The action reports should be limited to the Divisional Head Office, and plant deputy engineers and their supervisors.
- 9.7 The graph reports should be limited to the use of programming charts in the divisions, and plant utilisation charts in the central repair depot. The 'S' curve chart can be used for the heads of maintenance organisation, and administration department.
- 9.8 Informational reports should be prepared for the different level of management when needed.

APPENDIX 1

THE QUESTIONS, ANALYSIS AND CONCLUSION OF THE QUESTIONNAIRE

A questionnaire was designed to collect costing and financing data from the Highways Department. The questionnaire form was sent to ten counties by the Construction Methods Division, Highways Department, Transport and Road Research Laboratory, and visits to them for a field study were arranged. Only nine of these counties answered the questionnaire, but personal interviews with the Highways Department accountants were carried out in all the ten counties.

The Appendix contains the questions included in the questionnaire, an analysis of the results of the counties answers, and conclusions.

COUNTY WORKING PARTY ON THE ORGANISATION OF HIGHWAY MAINTENANCE

Survey of County Organisations for Maintenance

Cost Accounting

April 1972

Construction Methods Division

Highways Department
Transport and Read Research Laboratory
Department of the Environment
Crowthorne, Berkshire. RG11 6AU

1. General

The questions

- 1.1 Is there a chart outlining the functional relationships and levels of responsibility among the different departments of your authority? Yes No If yes, please attach a copy of the chart.
- 1.2 Please state briefly the jobs undertaken by the Highway Maintonance Department.
 - 1.2.1 By Direct Labour.
 - 1.2.2 By Contract.
- 1.3 Is there within the Highway Maintenance Department an operative Yes No scheme of job descriptions and job classification? If yes, please attach a copy of the scheme. Yes No If no, are you thinking of adopting one? 1.4 Does the department use computerised financial and cost Yes No accounting systems? Yes No 1.5 Are there any accounting and costing records? 1.6 State in general the sequence of the required stages involved in road building
- 1.7 Has there been in your experience some jobs which require more than one financial year for completion? Yes No

- 1. 33% of the counties only, have a chart outlining the functional relationships and levels of responsibility. This chart is available only in 22% of the counties.
- 2. There is no limit for the jobs which are carried out by direct labour and by contract in the counties.
- 3. 67% of the counties have an operative scheme of job descriptions and job classification, but these schemes were not made available to me. 33% of the counties have no such schemes at all.
- 4. ALL the counties use computer facilities in the cost accounting section, and they depend on the print out of the computer, instead of basic recording.
- 5. The cost accounting sections in all the counties have no idea about the stages of work involved in road building.
- 6. There are big jobs which need more than one year for completion in all the counties, and all these jobs are improvement jobs.

Conclusions

- 1. As a result of the lack of organisation chart, there are no clear channels of communication between the levels of management. As a result of the lack of written descriptions and job classification, there is also no adequate definition of responsibility for the members of the management staff.
- 2. The cost accounting system for the highway department must cover the maintenance work and the improvement work.
- 3. There is a lack of knowledge in the accounting sections about the information which is necessary for the engineers.

No

2. Financial Accounting

The questions

- 2.1 What are the sections of your Accounting Department?
- 2.2 Do you use any uniform accounting system which has been designed

 to meet the public sector accounting requirements?

 Yes

 If yes, please give brief details.
- 2.3 What are the financial accounting records used in your department?

Please attach a copy of each of these records.

If you use a computer, please give the Table headings.

2.4 Is the financial accounting department responsible for the preparation of periodical reports?
If yes, please describe these reports, to whom they are circulated, and how frequently.

Yes No

Please attach a copy of each type of report.

- 2.5 What are the sources of information included in these reports?
- 2.6 Is it usually easy to get this information from your present records?
 Yes No
 If no, why?
- 2.7 Have you an accounting code?

 If yes, please attach a copy of this code.

Yes No

2.8 Are there reliable estimates of next year's appropriations?

If yes, please state the basis of this estimate.

Yes No

2.9 Is it allowable to carry-over the current year's appropriation to complete any unfinished jobs in the next financial year?

If no, what are the sources of finance for this during the next year?

Yes No

and, what sort of treatment is usually applied to the unspent current year's funds?

Analysis of the Counties answers

- 1. There is no clear relation between the treasurer's department and the highway department.
- 2. The Marshall Standard Heading, and the Institute of Municipal Treasurer and Accountants (IMTA) Standard Accounts & the Department of Environment are used in all the counties to classify the Accounts.
- 3. There are no special records in the treasurers department for the highway department.
- 4. The Treasurers Department is not responsible for preparing any kind of internal report. It produces the County budget and a report to the Department of Environment regarding Expenditure on Trunk Roads every three months.
- 5. The Treasurers Department uses the computer facilities and the same code of the cost accounting system since the two systems are integrated. In only one county there is a different code for the treasurers department.
- 6. It is not permitted to carry over the current year's appropriation to complete unfinished jobs in the next year for the maintenance work, because this depends upon the revenue budget, and the unspent money at the end of the year is transferred to the county balance. It is permitted to carry over the current appropriation on improvement work, since this depends upon the capital budget on the Government grant.

Conclusions

- 1. The Treasurers Department includes the accounts of the Highway Department in its accounts, and it controls the expenditure according to the recommended heading of accounts by the IMTA/Marshall Report and the Department of Environment.
- 2. The Treasurers Department is responsible for preparing reports about the expenditure for outside parties only.
- 3. The Treasurers Department depends upon the cost accounting section in the Highway Department for only detailed information.
- 4. It is permitted to carry over the current appropriations to the following year if it is for improvement work, but not for maintenance work.

3. Cost Accounting

	The questions		31
3.1	Have you a complete system of cost accounting?	aeY	No
3.2	Do you regard it as necessary to have a cost accounting system separate from the financial accounting?	Yes	No
3.3	Define the cost accounting units, e.g. job, operation, etc		
3•4	State the theoretical basis of calculating the cost of the cost unit.		
3•5	Is there a reliable estimate of the capacity of your maintenance department?	Yes	Ио
3.6	Is your maintenance department divided into cost centres for the purposes of cost accounting? If yes, please attach a copy of these cost centres.	Yes	Ио
3.7	Is there a code for your cost centres? If yes, please attach a copy.	Yes	No
3.8	Does your cost analysis divide the cost elements into: 1. Direct - Indirect) Please tick where appropriate 2. Variable - Fixed)		
3.9	Have you a code for the cost elements? If yes, please attach a copy.	Yes	No
3.10	What are the cost accounting records used in your department?		

Please attach a copy of each of these records.

If you use a computer, please give the Table headings.

No

3.11 Do you verify the cost accounting results through comparisons with financial accounting results?

If yes, what is the procedure?

- 3.12 How do you allocate the cost of the following items to each cost unit?
 - 3.12.1 Transport cost of raw materials.
 - 3.12.2 Workshop repairs and maintenance.
 - 3.12.3 Storage costs.
 - 3.12.4 Administration costs.

Analysis of the Counties enswers

- 1. Every county has an actual costing system.
- 2. 33% of the counties regard it as necessary to have a separate cost accounting system. 22% regard it as necessary to have an integrated system for both cost accounting and financial accounting.
- 3. There are no standard units for cost accounting calculations.
- 4. There is no theoretical basis for calculating the cost unit in all the counties.
- 5. There are no estimates of maintenance capacity in the cost accounting system. The calculation of the capacity, if any, is usually done in the work study section, and it is for bonus scheme purposes only.
- 6. The counties regard the divisions as cost centres. They also have a cost centre for the depot, and sometimes for the bridges. Each division and depot has a number, which are regarded as a code for these centres.

7. 33% divides the cost elements into direct and indirect.
33% divides the cost elements into direct, indirect, variable, fixed
22% does not divide the cost elements at all
11% try to take out variable cost.

According to these results there are different codes for the cost elements in the different counties.

8. All these records use the outprint of the computer according to their codes. I did not get any of the headings of these tabulations since they were not made available. They make comparisons between the cost and financial records. This method differs in other counties.

4. Materials

The questions

- 4.1 What are the raw materials used in your department? Please give details.
- 4.2 What elements do you include in the total cost of your raw materials? e.g. Transport, haulage, discounts, etc.
- 4.3 Is there a separate store for each kind of material?

Yes No

4.4 Are there materials sub-stores for different operations?

les No

4.5 Is there a control system between main and sub-stores?

Yes No

- 4.6 What are the pricing bases for materials issued from main and sub-stores?
- 4.7 Is there a perpetual inventory for materials held in stores?

Yes No

4.8 What are the control documents of the main and sub-stores?

Please attach a copy of each document.

- 4.9 What are the control records? e.g. bin card, stores ledger card etc.
- 4.10 Are the material requisitions used for recording in stores control and the cost accounting records?
 If yes, please indicate the flow of documents.

Yes No

and then compare these with the standard cost?

cost and the standard cost?

4.

what do you do if there are deviations between the actual

- 1. Different kinds of materials are used in all the counties. Each county uses the appropriate material needed.
- 2. To calculate the total cost of materials, it depends upon the way of delivery. If the delivery is direct to the site, there is only one figure to include all the cost elements; if the delivery is by the counties vehicle, the cost of buying and cost of transport are put in two separate figures. There is no discount for the raw material.
- 3. There are stores in the divisional office for all the materials, and there are sub-stores for some kinds of materials, but there are none on the operation site, whatever the site may be. The relation between the stores and the sub-stores is different from one county to another. The pricing bases of the issued materials are also different in the counties.

56% of the counties are using the average cost as the pricing basis.

22% of the counties are using the average cost plus a percentage for handling.

11% of the counties are using FIFO

11% of the counties are using the current market price up-dated from time to time. The normal documents in the stores are:

1. Stores Requisition Note. 2. Stores Issue Note. 3. Stores Transfer Note.

There may be more documents in some of the counties; these documents are:-

- 1. Stores Received Note on sheet or voucher or List
- 2. Stock balance adjustment.

The central records in the counties are:-

1. bin card. 2. stores ledger by quantity only. 3. outprint of computer (price and quantity).

The flow of documents does not exercise a good control in the stores and it is not clear especially in the case of the excess material in operation and transferred to another.

4. The counties allocate the cost of materials transport from the stores to jobs according to the hourly rates which are different for every group of lcrries. They follow the same procedure whether they use the county vehicles or hire vehicles.

5. In the case of making the mixed concrete or asphalt by the counties own plant, the foreman estimates the quantity which is issued for every operation. If the county buys the mixture, they divide the invoice according to the delivery of materials to each job.

8% of the counties are using the actual cost of the mixture in the allocation of cost, but they did not show how they calculate this actual cost.

11% of the counties are using an estimated rate in order to allocate the cost, but this note is used for the plant only.

6. Only 11% of the counties have a crusher, and they use the actual cost for calculating the cost of the output from the crusher. However, they allocate the cost to the jobs according to a predetermined rate, and at the end of the year they perform a comparison between the actual cost and the allocated cost.

5. Labour

The questions

- 5.1 What are the kinds of workers in your department?
- 5.2 How do you estimate the correct number of workers required for each group?
- 5.3 How do you calculate thoir wages? e.g. time-rate, bonus scheme, etc.
- 5.4 What are the "associated labour costs" in addition to the actual cash payment of wages?

 Please specify these.
- 5.5 How do you allocate the wages on jobs and cost centres?
- 5.6 What are the records used for recording the wages in your department?

Please attach a copy.

If you use a computer, please give the Table headings.

- 5.7 What are the control documents for the wages of:
 - 1. Direct labour
 - ¿. Contractor's labour

Please attach a copy of each document.

5.8 Are the wages documents used for recording in the cost and financial records?
If yes, please indicate the flow of documents.

Aea No

5.9 How are wages paid?	Cash	Cheque	Other	
5.10 In cases of bad weather, do you pay	wages for time	e lost to:		
1. Direct labour			Yes	No
2. Contractor's labour			Yes	No
If yes, do you calculate it as	a cost element	?	Yes	No
5.11 Does the department provide any soc	cial service to	workers?	Yes	No
If yes, do you calculate it as a co			Yes	No
If yes, how do you allocate this co				

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Analysis of the counties antwers

- 87% of the counties are using permanent workers only.
 33% of the counties are using permanent and temporary workers.
- 2. The estimating of the correct number of workers required for a job is done in the work study section, or by the divisional surveyor.
- 3. All the counties calculate the wages of the workers by using the time rate plus a bonus scheme for the gang divided by the number of men, and this calculation is usually done in the work study section. The counties also regard the associated labour cost as an overhead. Therefore, they only allocate the wages and the bonus to the jobs according to the number of hours in every job, multiplied by the hourly rate.
- 4. The records which are used in the counties are:-
 - 1. Time sheet (different designs) 2. wages tabulation
 - 3. allocation to jobs.

The first one is a document, and the others are output of the computer. These records are used for the permanent and the temporary workers. The flow of documents is not clear because it does not show the relation between these documents, the work study section and the cost accounting section. The wages are paid to the workers in different forms of payment.

5. All the counties, keep paying wages to their workers, in tonditions of bad weather; some of them regard it as labour cost and include it in the wages, while some put it separately and other regard it as overheads.

6. Plant

The questions

- 6.1 County Council Plant.
 - 6.1.1 What are the kinds of plant owned by the County Council?
 - 6.1.2 Do you have a cost centre for:
 - 1. Vehicles

Yes No

2. Plant

Yes No

- 6.1.3 How do you calculate the actual cost for:
 - 1. Vehicles
 - 2. Plant
- 6.1.4 Do you have special records for these centres?

Yes No

If yes, please attach a copy

If you use a computer, please give the table headings.

6.1.5 Do you have special stores for spare parts

Yes No

If yes:

1. what are the control documents for these stores

Please attach a copy of each document

2. are these documents used for recording in stores control and cost accounting records?

Yes No

If yes, please indicate the flow of documents.

- 3. what are the pricing bases for the spare parts issued from the stores?
- 4. are material requisitions used for recording in store control aml cost accounting records?

Yes No

-6.1.6 Do you have special stores for fuel? (a) If yes: 1. what are the control documents for these stores? Please attach a copy of each document. 2. are these documents used for recording in No Yes stores control and cost accounting records? If yes, please indicate the flow of documents. 3. what are the pricing bases for the fuel issued from the stores? 4. are the material requisitions used for recording in stores control and cost accounting records? No (b) If no: 1. how do you calculate the actual cost for fuel? 6.1.7 How do you calculate the depreciation for: 1. Vehicles 2. Plant 6.1.8 How do you calculate the cost of maintenance for: 1. Vehicles. 2. Plant 6.1.9 How do you allocate these costs to the different kinds of plant? 6.1.10 Do you use standard costing rates for the allocation No Yes of costs to jobs? If yes, do you calculate the actual costs and Yes No then compare these with the standards? If yes, what do you do if there are deviations between the actual cost and the standard cost? 6.1.11 Do you calculate the drivers wages as part of plant costs? Yes No

323 Yes

No

6.2 Hired Plant.

- 6.2.1 How do you choose the source of plant which you intend to hire?
- 6.2.2 Can you estimate the quantity of plant and vehicles which you will need during the next year?

 If yes, what is the procedure?

Yes No

6.2.3 Do you use the hired plant and vehicles on a particular job or for several jobs?
If you use it for several jobs, how do you allocate the charge of hiring to these jobs?

One Several

- 6.2.4 Do you pay the charge for the hired plant on the basis of the actual work hours, or for a time period?
- 6.2.5 Do you pay these costs:

1.	fuel for plant and vehicles	Yes	No
2.	the wages of plant and vehicle drivers	aeY	No
3.	cost of maintenance	Yes	No
4.	overhaul and other repairs	Yes	No

If yes, how do you calculate these costs?

How do you allocate these costs to the jobs?

Analysis of the counties answers

- 1. The County Councils have different kinds of plant and vehicles, which are used variably in every county, according to their needs.
- 2. In identifying the plant cost centres in the counties, various methods have been operated. Some of the counties have one centre for the plant and vehicles. Some have cost counties for each group of vehicles and the others regard each plant as a cost centre.
- 3. The counties use the printout of the computer as a record, but it was not available for me to see these printouts.
- 4. There are stores for spare parts in all the counties. In 22% of the counties the stores are under the control of another department, the rest of the counties are using the same central documents, flow, pricing basis and records as for the raw material stores.
- 5. There are stores for fuel in the counties divisions. Some of the counties use the same central documents, flow, pricing basis and records as for the raw material and spare parts stores. The others use another kind of document, and another basis of pricing.
- 6. 67% of the counties are using the straightline method in calculating the depreciation of the plant.

22% of the counties are using the reducing balance method and 11% use different rates after the first year.

11% of the counties are using the straightline method for the first year and then different methods.

- 7. The county councils use the direct charge to the plant or group of plants in allocating the cost of maintenance.
- 8. The counties allocate the plant cost to jobs by using standard rates for every group of plants, and at the end of the year, if there are deviations between the actual cost and the charges, they revise the rate and try to cover the balance only.
- 9. 56% of the counties regard the drivers wages as part of the plant rate.
 44% of the counties do not regard it as part of the rate.

10. The counties choose the resources of hiring the plant by annual tender.

56% of the counties estimate the quantity of plant needed for the next period, but this is usually done by the plant engineer.

44% of the counties do not make any estimate.

All the counties pay the charge for the hired plant for a period of time; this may be for a minimum period of a day or a week, but in addition the counties pay a relief rate for idle time. The charge rate for hiring may include all the costs and may be the counties pay the cost to operate these plants.

Conclusions

- 1. It is necessary for the counties to have a separate cost accounting system, in order to serve management purposes.
- 2. There are no standard units for cost accounting calculation purposes also there are no cost accounting centres. The counties do not use any cost accounting theory in calculating the cost.
- 3. The counties use all kinds of materials; they include all the costs in one figure, if the material is delivered directly to the site, but they do not include the cost of transportation, in the material cost, if the delivery was by the county vehicle. This means that management is not able to make comparisons between the two costs, and if there is any discount they cannot discover it in order to take a decision about buying in bulk.
- 4. There is a need for proper control of material in the main and sub-stores, and there is a need also to study the basis of pricing the issued material from the stores to find the best basis for the highway department.
- 5. There is a need for finding a basis for calculating and allocating the cost of the mixed materials and for the output of the crushers.
- 6. The labour control is the responsibility of the work study section, but it is necessary for the cost accounting section to know the capacity of the labour force in order to build the flexible budget for the division.
- 7. There is a need for more control of the cost of operating the plant, and also there is a need to study the methods of depreciation to find the best method.

- 8. There is a need for accurate records which provide the financial information required for the decision making, also the flow of documents which shows the relation between the document and the records in the different sections, in order to control the cost of plant usage and its running repairing cost. There is also a need to find a suitable basis to allocate the cost of plant to jobs.
- 9. There is a need to calculate the county's own plant in order to build the flexible budget, and in order to know the exact numbers of plant required for the work during the next year, in order to take a decision whatever to buy new plant or to hire it.

7. Budgetary Control System

	and the state of t		
7.1	The questions Do you have a budgetary control system?	Yes	No
, .			
7.2	Who designs and constructs the budget?		
7.3	What are the bases and procedures for the design of budgets?		
		<i>‡</i>	
7.4	In designing the budgets, do you use: Standards/estimates		
7.5	How do you estimate the total cost of the job, in order to	* .	
, ,	take a decision whether to do the job by Direct Labour or by		
	Contract?		
76	Do you prepare a budget for every job?	Yes	No
7.6	no you propare a badget for every year		
7.7	Do you have a flexible budget for the department?	Yes	N_{O}
	If yes, what are the levels on which the flexible		*
	budget is based?		
		N P	37.
7.8	Do you calculate the production capacity for the department?	Yes	No
	If yes,		
	1. how do you calculate it?		
	2. is there any relationship between the assessment		
	of production capcity and the budgeting?	Yes	No
	If yes, what are the procedures?		
		:	
7.9			
	which play an important part in its construction?	Yes	No
	If yes, what is this factor?		
7 1	O Do you divide the annual budget into monthly or quarterly		•
1 • 1	budget periods? Yes Monthly Quarterly Other		

No

7.11	Do you translate the annual budget into work programmes?	Yes	No
7.12	When do you prepare the budget?		
7.13	Who is responsible for approving the departmental budget?		
7.14	In case of a job needing more than one financial year to complete, do you prepare a budget for the job in total?	Yes	No
7.15	Do you prepare a detailed budget for every operation within the job? If yes, what are the bases of your procedures?	Yes	No
7.16	Is there a relationship between the actual cost system and the budgetary control system?	Yes	No
7.17	Do you compare the actual cost and the budgets for every element of cost in every operation within the job? If yes, 1. do you make this comparison weekly or monthly? Weekly Mont	Yes	No ther
	2. do you analyse the deviation in order to discover the reasons for this deviation in order to take corrective action?	Yes	No
7.18	Can you get the actual cost information from the records? If yes, is it easy to get this information from your	Yes	No
	costing system?	Yes	No
7.19	When standards are used in the preparation of the job budget, who is responsible for fixing these standards?		

7.20 What are these standards? Please give details.

Analysis of the counties answers

- 88% of the counties have a budgetary control system.
 22% of the counties do not have this system.
- 2. The counties committees, the counties surveyor, the counties treasurer, and may be the assistant county surveyor and the divisional surveyor produce the budget estimate of the next year's expenditure.
- 3. The counties do not estimate the total cost of every job, except for big improvement operations, and they sually make a bill of quantities for this.
- 4. The counties do not have a flexible budget for the highways department. The cost accounting section does not know anything about the calculation of the departments capacity. These calculations, if any, are usually done in the work study section and by the plant engineer for their purposes and not for the purposes of building a flexible budget.
- 5. The limiting factor which affects the budget in all the counties is the availability of money.
- 6. There is no relation between the budget and the progress of work for comparison purposes.
- 7. The counties do not prepare budget for every operation within the job, but if it is a big job they may estimate the total cost and the total heading of expenditure. There are no comparisons at the cost element level. The counties also do not use physical standards in building the budget.

Conclusions

- 1. There is no proper budgetary control system in all the counties.
- 2. The counties present only a financial budget for the county council and there are some details in the highway department about the work during the next year according to the county budget, but these details are only in financial terms and for the total cost, and may be for the accounts headings.

- 3. There is no flexible budget in all the counties because the cost accounting section is not concerned with the calculation of capacity and there is no theoretical basis for calculating the unit cost.
- 4. There is no comparison between the actual performance and the estimated performance, except in financial terms and expenditure.

8. Reports

The questions

8.1 Is the cost accounting section responsible for the preparation of periodical reports?

Yes No

If yes, please describe these reports, to whom they are circulated, and how frequently.

Please attach a copy of each report and indicate the flow of these reports.

8.2 Is there any reporting on an "exceptions" basis?

Yes No

If yes,

- 1. when would such a report be prepared?
- 2. what is the flow of these reports?

Pleast attach a copy of each report.

Analysis of the counties answers

1. ALL the reports are financial reports about expenditure during the last period, and for comparison between the headings of the large improvement jobs and the financial estimates. The reports may take the form of output tabulations of the computer. The reports are distributed to the county surveyor, his assistant divisional surveyor and may be for the chief cost accountant.

2. The "exception" reports are produced if there is over expenditure on one of the schemes, and there are no rules for producing these reports.

Conclusion

There is a need for the reporting system for the Highways Department which presents the information required for the different levels of management according to their responsibility and ability to take corrective action as the existing reporting system is not sufficient.

THE COST UNITS AND COST CENTRES CODES

		T 1	
Main Code	Sub - Code	Cost Unit Code No.	Description
1	11	111	Maintenance operations Structural maintenance Surface dressing. This operation covers the work needed to seal porous surfaces against the entry of water, to bind surfaces at the onset of deterioration due to loss of stone etc., to delay further deterioration or to restore loss of skidding resistance (which may be due to loss of texture, polishing of the aggregate or fatting-up).
		112	Patching. It covers the work needed to repair local areas of serious deformation, crazing and cracking, potholes, erosion and edge failure of carriageways and unsatisfactory trench reinstatement. It also covers the work needed for the patching of concrete roads.
		113	Resurfacing. Resurfacing covers the work needed to correct general deterioration of the surface, deformation, structural failure, surface irregularity, unsatisfactory camber or cross-fall and under certain circumstances where surface dressing is inappropriate, the loss of skidding resistance, and to strengthen the pavement in anticipation of structural failure in the near future due to traffic loads. Resurfacing of concrete roads should also be coded under this code.
		114	Maintenance of footways. It covers all work needed to provide a reasonably safe path for pedestrians both by day and by night in rural and urban areas.
		115	Maintenance of kerbs. It covers the work needed to maintain kerbs in order to protect pedestrians, to provide water channels, to lead surface water into gullies and to define and support the edge of the carriageway.
		116	Maintenance of embankment and sides of cutting. It covers the work needed to preserve stability of slopes and rock cutting and to prevent damage by erosion. The sides of decp ditches should also be included under the general term of slopes.

		117	Siding and verge maintenance. It covers the work
-			needed to prevent the encroachment of verge soil and growth on to the carriageway and to maintain verges in a condition which allows the cutting of grass without damage to the machines.
		118	Gully emptying and maintenance of drainage system. It covers the work needed to ensure that surface water is removed from the carriageway as quickly as possible and not allowed to ponetrate to the foundation of the road.
	12		Aid to movement and safety operations.
		121	Snow and ice clearance. It covers the work needed to
			prevent or reduce the effects of adverse weather conditions on the movement of traffic, so that it can circulate in safety on the more important parts of the road network, and this type of work should be maintain bare wet surfaces on all important roads all the time. It also covers the salting and gritting.
		122	Maintenance of road markings and reflecting studs. It covers all work needed to define carriageway lanes and edges, warnings, parking and waiting restriction and to convey "Give Way" and other instructions to road users in a manner clearly visible by day and by night.
		123	Maintenance of traffic signs and bollards. This
			operation covers all work needed to keep all traffic signs legible and visible at all times, in relation to road use and traffic speeds.
		124	Maintenance of pedestrian crossings. It covers the
			work needed to indicate the presence of pedestrian crossings at all times. This should cover beacons and road markings.
		125	Maintenance of guard rails and safety and boundary fences.
			It covers all the work needed to maintain all the above in a sufficiently sound structural condition to serve their function, and not to be dangerous to road users or to pedestrians.
		126	Maintenance of traffic signals. This operation
			covers the work needed to maintain the existing traffic signals in correct operation at all times. This includes scouting for illumination, lamp changing, internal inspection, maintenance and cleaning etc.
		127	Maintenance of road lighting. It covers all work
			needed to maintain the designed standard of illumination with a reasonable degree of certainty.
	1	1	

		<u> </u>	
	13		Amenity functions operations.
		131	Grass, tree and hedge cutting. It covers the work
			needed to prevent obstruction of sight lines at bends and traffic signs, to inhibit the growth of injurious and other weeds, to maintain a tidy appearance, and in the case of trees adjoining roads to prevent them becoming a danger to road users.
		132	It covers the work needed to remove debris from the side channels, to prevent surface water ponding in them and an excess of detritus being washed down into gully pots, and to keep the carriageway surface generally clean so that road markings are visible and windscreens not obscured by dirty spray.
2			Improvement work operations (2)
	21/22		Structural operations
		211	Preliminaries. The work needed to carry out the following work should be included in this cost unit code: 1. Temporary accommodation
			 2. Servicing of temporary accommodation 3. Traffic safety and control 4. Temporary traffic diversions or bridges 5. Maintaining temporary traffic diversions or bridges 6. Removal and reinstatement of traffic diversions or bridges
			It should also include the cost of laboratory services.
		212	Site clearance. It covers all work needed to clear the site before starting the main construction work, thus it covers general site clearance, demolition of buildings or structures and the removal of disused sewers or drains below formation level.
		213	Hedges. It covers the work needed to plant new hedges, species of hedge, spacing of plants, or hedges with protective fencing.
		214	Fencing and walls. It covers the work needed to build fences, walls, gates, stiles and safety barriers.
		215	Drainage and service ducts. The work needed to build or carry cut the following works should be included under this cost unit code:-
			 Sewers, drains and ducts French drains Manholes, inspection chambers, catchpits and gullies Excavation of intercepting ditches Headwalls and outfall works

			6. Excavation in rock, pavement etc. 7. Reinstatement of pavement 8. Excavation of softspots and other voids 9. Supports left in excavation 10. Substructure drainage
216			Earthworks. The work needed to carry out all the work needed for earthworks should be included under this cost unit code. This covers the following:-
			 Excavation work in all types of soil Imported fill Compaction of fill Supports left in excavation Excavation of softspots and voids Soiling Grassing Completion of formation Paving of watercourses Clearance of existing ditches
		217	Sub-base and road base. It covers the work needed to build the sub-base, road base, the regulating course and scarifying pavement.
		218	Bituminous surfacing. It covers all work needed to build a flexible surfacing, regulating course and surface dressing.
		219	Concrete roads. It covers the work needed to build concrete carriageway, continuously reinforced concrete road base and edge beams.
		221	Footways, cycle tracks and kerbing. It covers the work needed to build the above work.
	23		Aid to movement
		231	Traffic signs. It covers the work needed for the complete installation of new traffic signs.
		232	Road marking. It covers the work needed to define carriageway lanes in new roads and installation of new road studs.
		233	Road lighting. It covers the work needed for laying new cables, erection of new columns, etc.

Main Code	Sub- Code	Main Group Code No.	Cost Centre Code No.	Description
3	31			Plant cost centres Vehicles
		311	3110	Vans
		312		Lorries
			31 21 31 22 31 23 31 24 31 25 31 26	3 Ton Diesel lorries 3 Ton Petrol lorries 5 Ton Diesel lorries 5 Ton Petrol lorries 7 Ton Diesel lorries 7 Ton Petrol lorries
		313		Special gritting lorries
			3131 3132	4 Ton lorries 7 Ton lorries
		314		Snow plough lorries *
		315		Line marking lorries *
		316		Concrete mixer lorries *
		317		Gully emptying lorries *
		318		Sweeper lorries *
		319		Trailers
			3191 3192 3193	Low loader trailers Ordinary trailers Water tank trailers
	32			Construction plant
		321		Excavators and shovels
			3211 3212 3213 3214 3215	Excavators Excavators/loaders Loading shovels Tractors Tractors/scraper
		322		Surfacing plant
			3221 3222 3223 3224 3225 3226 3227 3228	Emulsion sprayers (petrol engine) Emulsion sprayers (hand operated) Bitumen heaters Twin-burner heaters Planer Asphalt paver (Finishers) Screed spreaders Pre-coated chipping spreaders
		323		Compressors and breakers
			3231 3232	Air compressor (diesel) Tractor mounted air compressor loading
			3233	shovel Tractor mounted compressor with tool
			3234	trailer Pneumatic tool for air compressor

		324	3241 3242 3243 3244 3245 3246	Concreteing plant Mixers Poker vibrators Screed vibrators Pneumatic concretor Weigh batcher Concrete paver (finishers)
		325	3251 3252 3253 3254 3255 3256 3257	Rollers and compactors Petrol rollers Diesel rollers Tyred diesel rollers Vibratory rollers (powered) Vibratory rollers (hand) Sheepsfoot rollers Rammers
		326	3261 3262 3263 3264	Cranes Mobile cranes ACE hoist midget cranes Mobile hoist cranes Winches
·		329	3291 3292 3293	Miscellaneous construction plant Wheeled agricultural tractors with attachments Dumpers Motor graders
·	33	331 332 333 334 335 336 339		Special purpose plant Gritting plant * Grass mowers and attachments * Pumps portable * Welding and cutting sets * Saws (powered) * Sweepers * Miscellaneous plant and equipment *

^{*} Main groups which should be divided into a number of cost centres in the same manner as the rest of the main groups according to the County Council-owned plant.

^{1.} The description of maintenance cost units as described by "Report of the Committee on Highway Maintenance" Op.cit., p.106 - 128

^{2.} The description of improvement cost units as in "The Method of Measurement for Road and Bridge Works" Op.cit., p.13 - 62.

Main Code	Location Sub-code No.	Cost Centre Code No.	Description			
4			Administration cost centres			
,	41	410	Head office			
	42	420	Central repair depot			
	43	430	Central laboratory			
	44		Divisional administration offices			
		441 442 443 444	Division 1 Division 2 Division 3 Division 4			
		449	Division 9			
5	51	511 512 513 514 515	Central repair depot Maintenance workshop Engine repair workshop Electrical workshop Body repairs workshop Tyre repairs workshop			
	52	521 522 523 529	Divisional repair workshops Division 1 workshop Division 2 workshop Division 3 workshop Division 9 workshop			
	53		Central laboratory * Divisional laboratories *			
	54		DIAISIOUST 1800LSTOLLES			

^{*} Locations which should be divided into a number of cost centres according to the existing laboratories in the Highways Department.

APPENDIX THREE

THE COST ELEMENTS CODES

		7	·			
Main Code No•	Sub Code No.	Main Group Code No.	Sub Group Code No•	Sub-sub Group Code No.	Cost Element Code No.	Description
1						MATERIALS (1)
	11/12					Construction Materials
		111/112				Dry materials
			1111			Slag
					11111 11112 11113 11114	152mm - 228mm slag lump 76mm - 102mm slag rejects 38mm - 64mm " " 14mm slag chips
			1112			Granite
					11121 11122 11123	l4mm granite chips l0mm " " 6mm " "
			1113			Limestone
					11131 11132 11133	14mm limestone chips 10mm """ 6mm """
			1114			Aggregate
·					11141 11142	40mm aggregate 20mm "
			1115			Sand
					11151 11152 11153	Sand for concrete Sand for surface dressing Sand carpet
			1116			Dust
					11161 11162 11163	Slag dust Granite dust Limestone dust
			1117			Gravel
					11171 11172 11173 11174 11175	40mm max size gravel 20mm " " " 14mm " " " 10mm " " " binding footpath gravel
			1118			Flint
					11181 11182 11183	152mm - 228mm flint wholestone 102mm - 151mm " " " 50mm - 76mm flint rejects

^{1.} The conversion factor used to change imperial dimensions to metric is generally taken to be 300mm = lft. Materials which still exist under imperial specifications should be matched to the nearest metric equivalent.

	1			Sugar Sugar
	1119			Natural stone
				Stone walling
	1121			Silt
				Binding silt
	1122			Cl ay
				Puddle clay
	1123			Hard filling
			11231 11232 11233 11234 11235	127mm down crushed concrete 76mm " " " As raised material - hoggin Filling - rough material Hardcore (other than crushed concrete) Ashes
	1124		11250	Cements, etc
	11 24		11241 11242 11243 11244 11245 11246 11247	Ordinary portland Cement Fondu High Alumina Rapid hardening Sulphate resisting Lime Lime
	1125			Plastic materials
	-			
113				Pre-coated chippings
	1131			Slag
			11311 11312 11313	14mm slag chips 10mm " " 6mm " "
	1132			Granite
			11321 11322 11323	14mm granite chips 10mm " " 6mm " "
	1133			Limestone
			11331 11332 11333	14mm limestone chips 10mm " " 6mm " "
114				Pre-mixed materials
	1141			Bituminous
		11411	114111 114112 114113 114114 114115 114116 114117 114118	Dense bitumen macadam - slag 38mm Road base Table 18 29mm " " 19 38mm Basecourse Table 23 28mm " " 24 20mm " " 25 20mm Wearing course Table 5 14mm " " 5 10mm " " 5

_				342
		11412	114121 114122 114123 114124 114125 114126	Bituminous macadam - slag 38mm Basecourse Table 1 38mm Single course Table 2 20mm Wearing course Table 3 14mm " " " 3 10mm " " " 4
		11413	114131 114132 114133 114134 114135 114136 114137 114138	Dense bitumen macadam — granite 38mm Road base Table 18 28mm " " 19 38mm Basecourse Table 23 28mm " 24 20mm " " 25 20mm Wearing course Table 5 14mm " " " 5 10mm " " 5
		11414	114141 114142 114143 114144 114145 114146	Bituminous macadam - granite 38mm Basecourse Table 1 38mm Single course Table 2 20mm Wearing course Table 3 14mm " " " 3 10mm " " " 4
		11415	114151 114152 114153 114154 114155 114156	Gravel asphalt 38mm Roadbase 76mm Lean base 28mm Base course Wearing course 14mm Coated chipping 20mm " "
	1142	11421	114211	Non-bituminous materials Concrete Concrete mixtures Mortar (for brickwork and bedding kerbs)
115	1151	11511	115111 115112 115113 115114 115115 115116	Liquid construction materials Bituminous Emulsion 62% emulsion 60% " 50% " 40% " 30% "
		11512	1151 <i>2</i> 1 115131	Bitumen Cut-back bitumen Tar Ordinary tar
	1152	11514 11521	115141 115211	Mixed liquid Tar-bitumen material Non-bituminous Cement additives Plasticiser (eg. Plasmor)

			, 540
		115212 115213 115214	Colourand (eg. Cementone) Plasticiser (eg. Plasmor) Rapid hardener (eg. Green hydrol)
116			Bricks
117			Kerbs
	1171	11711 11712 11713 11714 11715 11716	Straight road kerbs 127 x 254mm straight 127 x 152mm " 127 x 254 x 600mm straight Radius - quadrants Radius road kerb - various 51 x 152mm path edging
	1172	11721 11722	Offset kerbs - concrete " " - cast iron
	1173	11731 11732	Kerbs - special types Special type DBA/2 " " DBK/2
	1174	11741 11742 11743	Channel blocks 102 x 254mm channel blocks 127 x 254mm " " Channels - continental
	1179	11791 11792 11793 11794 11795 11796 11797	Miscellaneous 450mm kerbs with 102mm hole Drop kerbs Ramp kerbs Kerbs - blue brick Kerbs - garden edge Kerbs - setts Radius - quadrants
118			Paving slabs
119			Steel reinforcement
	1191	11911 11912 11913 11914 11915 11916	Round bars 6mm diameter round bars 8mm " " " 10mm " " " 12mm " " " 16mm " " " 20mm " " "
	1192		Welded fabric
121			Expansion jointing
122			Concrete blocks
123	12 <u>31</u> 1232		Waterproof underlays Polythene sheeting Waterproof paper
I		1	·

_				011
13				Drainage materials
_3	131			Pipes
		1311	13111 13112	Unreinforced concrete pipes Ogee joints Flex. joints
		1312	13121 13122	Reinforced concrete pipes Ogee joints Flex. joints
		1313	13131 13132 13133 13134 13135 13136 13137	Porous pipes 75mm porous pipe 100mm " " 150mm " " 225mm " " 300mm " " 450mm " "
		1314	13141 13142 13143 13144 13145	Vitreous clayesore pipes 100mm glazed pipe 150mm " " 225mm " " 300mm " " 375mm " "
		1315	13151 13152 13153 13154 13155 13156	Miscellaneous pipes Asbestos pipes Pitch fibre pipes Corrugated metal pipes Steel pipes Pipes of synthetic material Cast or spun iron pipes
		1316	13161 13162 13163 13164 13165 13166 13169	Pipes - bends 100mm pipes - bends 150mm " " 225mm " " 300mm " " 450mm " " Pipes - bends various
		1317	13171 13172 13173 13174 13175 13176	Junctions Junctions largest intel up to 100mm " " " 150mm " " " 225mm " " " " 300mm " " " " 375mm " " " " 450mm
		1318	13181 13182 13183 13184	Saddles 100mm saddles 150mm " 225mm "
		1319	13191 13192	Collars 100mm collars 150mm "
	132	1321		Channels Channels

Construction		13211 13212	100mm diameter channel
		13213 13214 13215 13216 13217 13218	300mm " " 375mm " " 450 - 600mm diameter channel 601 - 900mm " " 901 - 1200mm " " 1201 - 1800mm " "
	1322	13221 13222	Channel gratings and frames 225mm wide 300mm "
	1323	13231 13232	Channel gratings 225mm wide 300mm "
133	1331		Gullies Pots
	1332	13321 13322 13323 13324 13325 13326 13327	Gratings and frames Grade E medium gully Gully grate and frames - medium " " - specials " " - Elkington 225 x 225mm grate and frame 238 x 15mm gully cover circular storm gully grate and frame
	1333	13331 13332 13333	Gratings 225 x 225mm grate 50 x 150mm " 254 x 188mm "
134			Inspection chambers, etc
	1341	13411 13412 13413 13414 13419	Chambers Inspection chamber crown unit 150mm intero unit inspection chamber 225mm " " " " 300mm " " " " Inspection chamber base unit
	1342	13421 13422 13423 13424 13425 13426	Inspection covers 450 x 450mm inspection covers - steel 600 x 450mm " " " 450 x 450mm " Frames - " 600 x 450mm " " cast Inspection frames - heavy Grade C light inspec. cover & frame
	1343	13431 13432 13433 13434 13435 13436 13437 13438 13439	900 x 600mm Chamber 300 x 300mm entry - 6in pipe 450 x 450mm " - 9in " 150 x 150mm corner unit 75 x 75mm " " 600mm straight filler unit 750mm " " " 100 x 75mm cover slab 300mm L unit L unit

13	5	Catchpits and manholes
	1351	Precast concrete rings 675mm shaft rings, internal dia. 900mm manhole, internal dia. 13513 1050mm " " " 13514 1350mm " " " 13506 13517 1800mm " " "
	1352	Precast concrete cover slabs to suit rings 13521 675mm internal diameter 13522 750mm " " 13523 900mm " " 13524 1050mm " " 13525 1200mm " " 13526 1350mm " " 13527 1500mm " " 13528 1800mm " "
	1353	Precast taper rings reducing to 657mm 13531 900mm internal diameter 13532 1050mm " " 13533 1200mm " " 13534 1350mm " " 13535 1500mm " " 13536 1800mm " "
	1354	Covers 13541 Crade A heavy triang. cover & frame Crade B medium circ. " " Crade B medium rect. " " Manhole cover circular Manhole cover ring Manhole cover heavy 13546 Manhole cover heavy 600 x 450mm manhole cover
	1355	Miscellaneous manhole materials
1:	1391	Miscellaneous drainage materials Chamber rings, small size 13911 75mm internal diameter 13912 150mm " " 13913 225mm " " 13914 300mm " "
	1392 1393 1394 1395 1396	Gutters Spigots Sockets Stoppers Diminishers

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14					Aid to movement materials
	141				Fencing
		1411			Wire
			14111	141111 141112 141113	Fences Fencing wire stranded "" single stranded " Barbed
			14112	141121 141122	Netting 1200mm ht wire netting 900mm " "
			14119	141191	Miscellaneous
		1412			Wood
			14121	141211 141212 141213 141214	Fences Wooden fences up to 2m " " over 2m Struts - wooden fencing Chestnut fencing
		1413			Metal
			14131	141311 141312 141313 141314 141315 141316 141317 141318	Tubing 25mm metal tubing 30mm " " 40mm " " 45mm " " 47mm " " 50mm " " Metal tubing unions Metal tubing sockets
			14132	141321	Chain Chain link fencing
		1414			Gates
		1415	14151	141511 141512 141513	Concrete posts Posts Concrete posts up to 2m " " over 2m Struts - concrete posts
	142				Signs
	·	1421			Tubulars
			14211	142111 142112 142113 142114 142115	50mm diameter up to 1800mm standards over 1800 - 2100mm " over 2100 - 2400mm " over 2400 - 2700mm " over 2700 - 3000mm "
			14212	142121 142122 142123 142124	75mm diameter up to 1800mm standards over 1800 - 2100mm " over 2100 - 2400mm " over 2400 - 2700mm "

	142125 142126	over 2700 - 3000mm standards
	142127 142128 142129	over 3000 - 3300mm over 3300 - 3600mm over 3600 - 4200mm over 4200 - 4800mm
14213	142131 142132 142133 142134 142135 142136 142137 142138 142139	Internally wired upto 1800mm standards over 1800 - 2100mm " over 2100 - 2400mm " over 2400 - 2700mm " over 2700 - 3000mm " over 3000 - 3300mm " over 3300 - 3600mm " over 3600 - 3900mm " over 3900 - 4200mm "
22		Plain and reflective signs
14221	142211 142212 142213 142214	Triangular signs 600mm ht triangular 750mm ht " 850mm ht " 950mm ht "
14222	142221 142222 142223 142224 142225 142226 142227 142228 142229	Circular signs 265mm diameter 300mm " 400mm " 500mm " 600mm " 750mm " 800mm " 1000 - 1125mm " 1200 - 1500mm "
14223	142231 142232 142233 142234 142235 142236 142237 142238	Longest side rectangular signs up to 475mm 500 - 725mm 750 - 975mm 1000 - 1225mm 1250 - 1725mm 1750 - 2425mm 2500 - 3675mm over 3700mm
23		Internally illuminated signs
14231	142311 142312 142313 142314	Triangular signs 600mm ht triang. illuminated 750mm " " " 850mm " " "
14232	142321 142322 142323 142324 142325 142326 142327	Circular signs 600mm diameter illuminated 750mm " " 800mm " " 1000mm " " 1125mm " " 1200mm " "
	22 14221 14222 14223	142131 142132 142133 142134 142135 142137 142138 142139 22 14221 14221 14221 14221 14221 14222 14222 14222 14222 14222 14223 142226 142227 142226 142227 142228 142229 14223 14223 14223 142232 142233 142234 142235 142236 142237 142238 23 14231 14231 142312 142323 142238 23 14231 142312 142313 142314 14232 142323 142313 142314 14232 142323 142323 142323 142326 142323 142323 142326

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			14233	142331 142332 142333 142334	Longest side rectangular signs up to 475mm rect. illum. 500 - 725mm " " 750 - 975mm " " 1000 - 1225mm " "
		1424			Bollards
			14241	142411 142412 142413 142414 142415 142416 142417	Parts Keep left bollard - body assembly
			14242	142421 142422 142423 142424	Complete unit Keep left bollard - 1 aspect " - 2 " " - 3 " " - 4 "
		1425			Posts
			14251	142511 142512	Safety posts Metal safety posts Plastic " "
	-		14252	142521 142522	Direction posts Direction posts complete " " - oak
			14253	142531 142532	Sign posts Sign post - cast iron " " - " " MOT
		1426		14261 14262 14263 14264	Roadstuds Roadstuds complete Roadstuds - stainless steel " - replacement pads " - frames only
		1427			Paint
			14271	142711 142712 142713	Road paint Road line paint Catseye masking for surface dress. Bitumastic paint
			14272	142721 142722 142723 142724 142725 142726 142727 142728	Miscellaneous paint Primer - all types Undercoat - all types Gloss - all types Thinners for all types Red lead (Glopane) Metal preservative (Metalife) Rust preventative Evode vehicle coating
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	143				Street lighting
	·	1431			Lamps
		13-	14311	143111 143112 143113 143114 143115 143116 143117 143118 143119	Fluorescent lamps 6w 200mm standard fluorescent 8w 300mm 13w 325mm 15w 450mm 20w 600mm 30w 900mm 40w 600mm 40w 1200mm 11
			14312	143121 143122	Sodium lamps High pressure Low pressure
			14313	143131 143132	Tungsten lamps 25/100w Tungsten 150w/ "
		1432			Columns
			14321	143211 143212	Double bracket arms Concrete Steel
			14322	143221 143222	Single bracket arms Concrete Steel
			14323	143231 143232	Double arms Concrete Steel
			14324	143241 143242	Single arm Concrete Steel
			14325		Single brackets
		1433			Lanterns and control gear
			14331	143311 143312	Lanterns with control gear Alpha Beta
Name of the last o			14332	143321 143322	Lanterns Alpha Beta
			14333	143331 143332	Lantern bowl Alpha Eeta
			14334	143341 143342	Transformers Transformers AME 31784 " 3182T
			14335	143351 143352	Capacitors Capacitors AMEC 2214 " " 2218

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	1434	55144444444444444444444444444444444444		Cables	
		14341	143411 143412 143413	Single core cable l.5mm black single core l.5mm red " " 2.5mm green " "	
		14342	143421 143422 143423 143424 143425	Three-core cable 2.5mm three-core armoured 4.0mm " " " 6.0mm " " " 10.0mm " " "	
	1439			Miscellaneous street lighting materials	

15			SCHOOL STATE OF STATE	Miscellaneous materials
	151			Liquid materials
		1511	15111 15112	Water Water (supplied to operations) Distilled water
		1512	15121 15122 15123 15124 15125 15126 15127 15128	Oil Lubricating oil Gear box oil Brake fluid Rear axle oil Flushing oil Compressor oil Paraffin oil Mould oil
		1513	15131 15132 15133 15134	Fuel gas Petrol Diesel Coal Coke
		1514	15141 15142 15143 15144 15145 15146 15147	Miscellaneous liquid materials Anti-freeze Bitumen latex compound Waterproofing compound Plastic white line compound Plastic reflective line compound Chemical drain cleaners Curing compound
	152			Gas
		1521 1522 1523	15210 15220 15230	Propane Oxygen Acetylene
	153			Grease
		1531 1532 1533	15310 15320 15330	Soft grease Brake mechanism Wheel hub bearings
	154			Timber
		1541	15411 15412 15413 15414 15415 15416	25mm depth 25 x 50mm timber " x 100mm " " x 150mm " " x 200mm " " x 250mm " " x 305mm "
		1542	15421 15422 15423 15424 15425	50mm depth " x 50mm timber " x 100mm " " x 150mm " " x 250mm " " x 250mm "
		1543	15431 15432 15433 15434	75mm depth " x 100mm timber " x 150mm " " x 200mm " " x 250mm "

		1544	15441 15442 15443	100mm depth " x 100mm timber " x 150mm " " x 200mm "
	155			Steel
		1551 1552 1553 1554		Steel bars Grade A " " B " plates " sheeting
	156			Parts for plant *
		1561 1562 1563 1564		Spare parts Tyres Batteries Body repairs — "Materials only"
	157			Chemical materials for laboratories

^{*} All groups classified under this main group should be broken down into a number of elements according to the type of material.

	16				Special purpose materials
		161			Winter maintenance material
***************************************			1611 1612	16110 16120	Salt Sand for gritting
		162			Baskets
			1621 1622 1623		Small litter baskets Large litter baskets Sack stand for litter baskets
		163			Bags
			1631 1632		Sand bags Sacks
		164			Fixings - Steel and plastic
	!		1641 1642 1643		Nuts, bolts and washers Nails Screws
		165			Trees and grass - maintenance
			1651 1652 1653 1654 1655		Grass seed Trees Tree stakes Tree ties Tree pads
		166			Cotton waste
			1661 1662 1663		Waste Coloured wipers Rags

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19			independent of the second of t	Company of the second	Haulage
	191				Haulage for construction materials
		1911	19111 19112		Dry materials County Council lorries Hired lorries
		1913	19131 19132		Pre-coated chippings County Council lorries Hired lorries
		1914			Pre-mixed materials
			19141	191411 191412	County Council lorries Bituminous material Non-bituminous material
			19142	191421 191422	Hired lorries Bituminous material Non-bituminous material
		1915			Liquid materials
			19151	191511 191512	County Council lorries Bituminous material Non-bituminous material
			19152	191521 191 5 22	Hired lorries Bituminous material Non-bituminous material
		1916	19161 19162		Bricks County Council lorries Hired lorries
		1917	19171 19172		Kerbs County Council lorries Hired lorries
		1918	19181 19182		Paving slabs County Council lorries Hired lorries
		1919	19191 19192		Steel reinforcement County Council lorries Hired lorries
		1921	19211 19212		Expansion jointing County Council lorries Hired lorries
		1922	19221 19222		Concrete blocks County Council lorries Hired lorries
		1923	19231 19232		Waterproof underlays County Council lorries Hired lorries
	193				Haulage for drainage materials
	-/-	1931	19311 19312		Pipes County Council lorries Hired lorries
		1932	19321		Channels County Council lorries
			19322		Hired lorries
		***	J		J

		_		356
***************************************		1933	19331 19332	Inspection chambers County Council lorries Hired lorries
		1934	19341 19342	Gullies County Council lorries Hired lorries
		1935	19351 19352	Catchpits and manholes County Council lorries Hired lorries
-		1939	19391 19392	Miscellaneous drainage materials County Council lorries Hired lorries
	194			Haulage for "Aid to Movement" materials
		1941		Fencing
-			19411 19412	County Council lorries Hired lorries
-		1942	19421 19422	Signs County Council lorries Hired lorries
-		1943	19431 19432	Street lighting materials County Council lorries Hired lorries
	195			Haulage for miscellaneous materials
	177	1951	19511 19512	Liquid materials County Council lorries Hired lorries
		1952	19521 19522	Gas County Council lorries Hired lorries
		1953	19531 19532	Grease County Council lorries Hired lorries
		1954	19541 19542	Timber County Council lorries Hired lorries
		1955	19551 19552	Steel County Council lorries Hired lorries
		1956	19561 19562	Parts for plant County Council lorries Hired lorries
		1957	19571 19572	Chemicals for laboratories County Council lorries Hired lorries
	196			Special purpose materials
	2,70	1961	19611 19612	Winter maintenance material County Council lorries Hired lorries
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1962	19621	Baskets County Council lorries
1963	19622	Hired lorries Bags County Council lorries
1964	19632 19641 19642	Hired lorries Fixings County Council lorries Hired lorries
1965	19651 19652	Trees & grass maintenance County Council lorries Hired lorries
1966	19661 19662	Cotton waste County Council lorries Hired lorries

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2						LABOUR
	21		The state of the s			Permanent roadmen
		211				Wages
			2111		21111 21112	Basic payment Working time Travelling time
			2112		21121 21122 21123 21124	Idle time Bad weather Breakdown of plant Lack of materials Lack of equipment
			2113		21131 21132 21133 21134	Overtime payment Normal rate Time-and-third rate Time-and-half rate Double time rate
		212				Bonus payment
		213		Annie Annie		Employment cost (C.C.contribution)
-			21 31 21 32 21 33			National health insurance Graduated National Insurance Superannuation
	22					Temporary labour
		221				Wages
,			2211		22111 22112	Basic payment Working Time Travelling time
·			. 2212		22121 22122 22123 22124	Idle time Bad weather Breakdown of plant Lack of materials Lack of equipment
			2213		22131 22132 22133 22134	Overtime payment Normal rate Time-and-third rate Time-and-half rate Double time rate
		222				Bonus payment
		223	2231 2232 2233			Employment cost (C.C.contribution) National health insurance Graduated National Insurance Superannuation

1				
23				Permanent drivers & plant operators
	231			Wages
		2311	23111 23112	Basic payment Working time Travelling time
		2312	231 21 231 22 231 23 231 24 231 25	Idle time Bad weather Breakdown of plant Lack of materials Lack of equipment Repair & maintenance (by Driver)
		2313	23131 23132 23133 23134	Overtime payment Normal rate Time-and-third rate Time-and-half rate Double time rate
	232			Bonus payment
	233			Employment cost (C.C.contribution)
		2331 2332 2333		National health insurance Graduated National Insurance Superannuation
24				Temporary drivers & plant operators
	241			Wages
		2411	24111 24112	Basic payment Working time Travelling time
		2412	24121 24122 24123 24124 24125	Idle time Bad weather Breakdown of plant Lack of materials Lack of equipment Repair & maintenance (by driver)
		2413	241 31 241 32 241 33 241 34	Overtime payment Normal rate Time-and-third rate Time-and-half rate Double time rate
	242			Bonus payment
	243			Employment cost (C.C.contribution)
		24 31 24 32 24 33		National health insurance Graduated National Insurance Superannuation

25				Drivers & plant operators for hired plant
	251			Wages
		2511	25111 25112	Basic payment Working time Travelling time
		2512	25121 25122 25123 25124 25125	Idle time Bad weather Breakdown of plant Lack of materials Lack of equipment Repair & maintenance (by driver)
		2513	25131 25132 25133 25134	Overtime payment Normal rate Time-and-third rate Time-and-half rate Double time rate
	252			Bonus payment
26				Fitters
	261			Wages
		2611 2612	26110 26120	Basic payment Overtime payment
	262		26200	Bonus payment
	263			Employment cost
		2631 2632 2633	26310 26320 26330	National health insurance Graduated National Insurance Superannuation
27				Technicians
41	271			Wages
		2711 2712		Basic payment Overtime payment
	273			Bonus payment
	274	2741 2742 2743		Employment cost National health insurance Graduated national insurance Superannuation

3					GARMORETE	PLANT
	31					Vehicles
		311	3111 3112			Vans County Council vans Hired vans
		312				Lorries
			3121		31 21 1 31 21 2 31 21 3 31 21 4 31 21 5 31 21 6	County Council lorries 3 Ton diesel lorries " " petrol " 5 " diesel " 7 " diesel " " " petrol "
			3122		31 221 31 222 31 223 31 224 31 225 31 226	Hired lorries 3 Ton diesel lorries " " petrol " 5 " diesel " " " petrol " 7 " diesel " " " petrol "
		313				Special gritting lorries
			3131 3132			County Council lorries Hired lorries
		314	3141 3142			Snow plough lorries County Council lorries Hired lorries
		315	3151 3152			Line marking lorries County Council lorries Hired lorries
•		316	31 <i>6</i> 1 · 31 <i>6</i> 2			Concrete mixer lorries County Council lorries Hired lorries
		317	3171 3172			Gully emptier lorries County Council lorries Hired lorries
		318	3181 3182			Sweeper lorries County Council lorries Hired lorries
		319	3191		31911 31912 31913	Trailers County Council trailers Low loader trailers Ordinary trailers Water tank trailers
			3192		31921 31922 31923	Hired trailers Low loader trailers Ordinary trailers Water tank trailers
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			Construction plant
321	A		Excavators and shovels
	3211	32111 32112 32113 32114 32115	County Council plant Excavators Excavator/loader Loading shovels Tractors Tractor/scraper
	3212	321 21 321 22 321 23 321 24 321 25	Hired plant Excavators Excavator/loader Loading shovels Tractors Tractor/scraper
322			Surfacing plant
	3221	32211 32212 32213 32214 32215 32216 32217 32218	County Council plant Smulsion sprayers (petrol engine) " " (hand operated) Bitumen heaters Twin-burner heaters Planer Asphalt paver finisher Screed spreaders Pre-coated chipping spreaders
	3222	32221 32222 32223 32224 32225 32226 32227 32228	Hired plant Emulsion sprayers (petrol engine) " " (hand operated) Bitumen heaters Twin-burner heaters Planer Asphalt paver finisher Screed spreaders Pre-coated chipping spreaders
323			Compressors and breakers
	3231	32311 32312 32313	County Council plant Air compressors - diesel Tractor mounted compressor/loader """ with
		32314	tool trailer Pneumatic tools for air comp.
	3232	32321 32322 32323 32324	Hired plant Air compressors - diesel Tractor mounted compressor/loader """ with tool trailer Pneumatic tools for air comp.
324			Concreting plant
) Z-4	3241	32411 32412 32413 32414 32415 32416	County Council, plant Mixers Poker vibrators Screed vibrators Pneumatic concretor Weigh batcher - hand loaded Concrete paver (finisher)
	322	3212 322 3221 323 3231 3232	3211 32112 32113 32114 32115 3212 32121 32122 32123 32124 32125 3221 3221 32212 32213 32214 32215 32216 32217 32218 32222 32223 32224 32222 32223 32224 32227 32228 3231 3231 3231 3231 32314 3232 32323 32324 32324 32323 32324 32324 32323 32324 32324 32323 32324 32323 32324 32324 32323 32324 32324 32323 32324 32324 32323 32324 32324 32323 32324 32324 32323 32324 32324 32323 32324

3242 3242						363
3251 32511 32512 Diesel " - tyred 32513 Signal 32514 Vibratory rollers (powered) " (hand) Sheepsfoot roller Rammers Hired plant Petrol rollers 23522 Petrol rollers Diesel " - tyred 32517 Rammers Hired plant Petrol rollers Diesel " - tyred 32524 Vibratory rollers (powered) " (hand) Sheepsfoot roller Rammers Diesel " - tyred 32524 Vibratory rollers (powered) " (hand) Sheepsfoot rollers Rammers Size Sheepsfoot rollers Rammers Size Tennes Tenne				3242	32422 32423 32424 32425	Mixers Poker vibrator Screed vibrators Pneumatic concretor Weigh batcher - hand loaded
32511 Petrol rollers Diesel " tyred 32512 32513 " tyred 12515 32516 Sheepsfoot roller (hand) 32517 Rammers Hired plant Petrol rollers 12522 32523 " tyred 12524 32525 " thand) 12525 32526 Sheepsfoot rollers 12526 32527 Rammers The petrol rollers 12526 Sheepsfoot rollers			325			Rollers and compactors
32521 Petrol rollers Diesel - tyred				3251	32512 32513 32514 32515 32516	Petrol rollers Diesel " " - tyred Vibratory rollers (powered) " " (hand) Sheepsfoot roller
3261 32612 32613 32612 32613 32614 32614 32621 32621 32621 32622 32622 32622 32622 32623 32624 32624 32624 32624 32624 32624 32625 32624 32625 326263 32624 326263 32624 326263 32624 326263 32624 Winches Miscellaneous construction plant County Council plant Wheeled agricultural tractor with attachments Dumpers Graders Hired plant Wheeled agricultural tractor with attachments Dumpers Graders Hired plant Wheeled agricultural tractor with attachments Dumpers Graders Special purpose plant Gritting plant Gritting plant County Council plant petrol engine trailer gritter				3252	325 22 325 23 325 24 325 25 325 26	Petrol rollers Diesel " " " - tyred Vibratory rollers (powered) " " (hand) Sheepsfoot rollers
3261 32612 ACW hoist midget cranes 32613 Mobile hoist cranes 3262 Hired plant 3262 ACB hoist midget cranes 32621 Mobile hoist cranes 32623 ACB hoist midget cranes 32624 Mobile hoist cranes 32624 Miscellaneous construction plant 3291 County Council plant 3291 Wheeled agricultural tractor with 32912 32913 Graders 3292 Hired plant 3292 Hired plant 3292 ACB hoist midget cranes 3291 Wheeled agricultural tractor with 32912 ACB hoist midget cranes 32624 Mobile hoist cranes 32624 Winches Mobile cranes ACW hoist midget cranes ACB hoist	ļ		326			Cranes
3292 32922 32923 32922 32923 32922 32923 32924 32922 32923 32924 32924 32925 32925 32926 32927 32927 32927 32928 32928 32928 32928 32929 32929 32929 32920 32920 32921 32921 32921 32921 32922 32923 32923 32923 32923 32923 32924 32924 32925 32925 32926 32927 32927 32928 32928 32928 32928 32928 32928 32928 32928 32928 32928 32929 32929 32929 32920 32				3261	32612 32613	Mobile cranes ACE hoist midget cranes Mobile hoist cranes
3291 County Council plant Wheeled agricultural tractor with attachments Dumpers Graders Hired plant Wheeled agricultural tractor with attachments Dumpers Graders Wheeled agricultural tractor with attachments Dumpers Graders Special purpose plant Gritting plant County Council plant Petrol engine trailer gritter				3262	32622 32623	Mobile cranes ACE hoist midget cranes Mobile hoist cranes
32911 Wheeled agricultural tractor with attachments 32912 Dumpers Graders Hired plant Wheeled agricultural tractor with attachments Dumpers Graders 32921 Special purpose plant Gritting plant County Council plant Petrol engine trailer gritter			329			Miscellaneous construction plant
32921 32921 Wheeled agricultural tractor with attachments Dumpers Graders Special purpose plant Gritting plant County Council plant Petrol engine trailer gritter				3291	32912	Wheeled agricultural tractor with attachments Dumpers
32922 32923 Dumpers Graders Special purpose plant Gritting plant County Council plant 3311 Petrol engine trailer gritter				3292		Hired plant
331 Gritting plant County Council plant Petrol engine trailer gritter					32922	attachments Dumpers
331 Gritting plant County Council plant Petrol engine trailer gritter		1 1				Special purpose plant
3311 County Council plant 33111 Petrol engine trailer gritter		33	33]			
			<u> </u>	3311		County Council plant Petrol engine trailer gritter

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		3312	33121 33122	Hired plant Petrol engine trailer gritter Independent bulk gritter
	332			Grass mowers and attachments
		3321	33211 33212 33213 33214	County Council plant Motor mowers Motor mowers with snowplough attached Long reach embankment mower "Flail" mowers (pedestrian control)
		3322	33221 33222 33223 33224	Hired plant Motor mowers Motor mowers with snowplough attached Long reach embankment mower "Flail" mowers (pedestrian control)
	333	3331	33311 33312 33313	Pumps portable County Council plant Centrifugal pumps Diaphragm pumps Well points (dewatering)
		3332	33321 33322 33323	Hired plant Centrifugal pumps Diaphragm pumps Well points (dewatering)
	334			Welding and cutting sets
		3341	33411 33412	County Council plant Electric welders - portable - Lincoln Rover
		3342	33421 33422	Hired plant Electric welders - portable " - Lincoln Rover
-	335			Saws (powered)
		3351	33511 33512 33513	County Council plant Circular saws Chain saws Reciprocating saws
		3352	33521 33522 33523	Hired plant Circular saws Chain saws Reciprocating saws
	336			Sweepers
		3361	33611 33612	County Council plant Footpath sweepers Rotary brooms
		3362	33621 33622	Hired plant Footpath sweepers Rotary brooms
	,	•	•	

339	3391	33911 33912 33913 33914 33915 33916	Miscellaneous plant and equipment County Council plant Lighting generators Lighting sets (Lumination) Traffic control signals Line marker Tunnel sheltering equipment In-situ soil equipment
	3392	33919 33921 33922 33923 33924 33925 33926 33929	Trailer type offices Hired plant Lighting generators Lighting sets (Lumination) Traffic control signals Line marker Tunnel sheltering equipment In-situ soil equipment Trailer type offices

					300
4	41	411		41100	FXPENSES Cost Units Expenses Hire of sites
	42	421	College and the control of the college and the	42100	Service cost centre expenses Electricity
	43	431 432 433 434 435		43100 43200 43300 43400 43500	Mobile plant expenses Garaging charges Gas cylinders rental Moving of plant Erection of plant Strengthening of crossings
	44	441 442 443 444 445 446		44000 44100 44200 44300 44400 44500 44600	Service cost centres overheads Maintenance workshop Engine repairs workshop Electrical repair workshop Body repair workshop Tyre repair workshop Divisional workshops
	45		PPRINCE		Laboratories service cost centre costs

			Çî serie	The second	
5					CONTRACTORS WORK
	51				Maintenance work
		511	5111 5112 5113 5114 5115 5116	51110 51120 51130 51140 51150 51160	Structural maintenance Surface dressing Patching Resurfacing Maintenance of footways Maintenance of kerbs Maintenance of embankment and sides of cutting
			5117 5118	51170 51180	Siding and verge maintenance Gully emptying and maintenance of drainage system
		512	51 21 51 22	51 210 51 220	Aid to movement maintenance Snow and ice clearance Maintenance of road markings and reflective studs
			51 23	51 230	Maintenance of traffic signs and bollards
			51 24· 51 25	51 240 51 250	Maintenance of pedestrian crossings Maintenance of guard rails, safety and boundary fences
			51 26 51 27	51 260 51 270	Maintenance of traffic signals Maintenance of road lighting
		513	51 31 51 32		Amenity functions operations Grass, tree and hedge cutting Sweeping and cleansing
•	52				Improvement work
		521/522	5211 .5212 5213 5214 5215 5216 5217 5218 5219 5221	52110 52120 52130 52140 52150 52160 52170 52180 52190 52210	Structural work Preliminaries Site clearance Hedges Fencing and walls Drainage and service ducts Earthworks Sub-base and road base Bituminous surfacing Concrete roads Footways, cycle tracks and kerbing
		523	5231 5232 5233	52310 52320 52330	Aid to movement Traffic signs Road markings Road lighting
	53	531	5311	53111 53112	Plant repairs Maintenance work Vehicles Vans Lorries

•	1	Б.		368
		5312	531 21 531 22 531 23 531 24 531 25 531 26	Construction plant Excavators and shovels Surfacing plant Compressors and breakers Concreting plant Rollers and compactors Cranes
			53129	Miscellaneous plant
		5313	531 31 531 32 531 33 531 34 531 35 531 36	Special purpose plant Gritting plant Grass mowers and attachments Pumps portable Welding and cutting sets Saws Sweepers
			53139	Miscellaneous plant and equipment
	532			Engine repairs *
		5321		Vehicles
		5322		Construction plant
		5323		Special purpose plant
	533			Ele c tri c al repairs *
	534			Body repairs *
	535			Tyre repairs *

^{*} To be classified and coded in the same manner as main group 531 maintenance work.

	1	8 6		
				FIXED COSTS
61				Administrative materials and utilities
	611 612 613 614		61100 61200 61300 61410 61420	Printing and stationery Text books Maps and plans Protective clothing Boots Shoes
	615			Utilities (Supplied for heating,
			61510 61520 61530 61540	lighting, etc) Water Electricity Gas Coal
62				Employees Cost
	621	6211 6212 6213	62110 62120 62131 62132 62133	Technical Staff Salaries Overtime Employment cost National Health Insurance Craduated National Insurance Pension Superannuation
		6214	62141 62142 62143 62144 62145 62146 62147	Expenses Travelling and subsistence Compensation for loss of office Gratuities for dependants Ex gratia payment employees Financial aid Redundancy payment Training courses and examination fees
	622	6221 6222 6223	62210 62220 62231 62232 62233	Clerical Staff Salaries Overtime Employment cost National Health Insurance Graduated National Insurance Pension Superannuation
		6224	62241 62242 62243 62244 62245 62246 62247	Expenses Travelling and subsistence Compensation for loss of office Cratuities for dependants Ex gratia payment employees Financial aid Redundancy payment Training courses and examination fees
	623			Inspectors, Foremen & Superintendents
		6231 6232 6233	62310 62320 62331 62332	Salaries Overtime Employment cost National Health Insurance Graduated National Insurance Pension
		611 612 613 614 615	611 612 613 614 615 621 621 6212 6213 6214 6224 623 6231 6232	611 612 61300 61200 61300 61300 61300 61300 61420 61420 61510 61520 61530 61530 6154

	6234	62341 62342 62343 62344 62345 62346 62347	Expenses Travelling and subsistence Compensation for loss of office Gratuities for dependants Ex gratia payment employees Financial aid Redundancy payment Training courses and examination fees
624			Roadmen
	6241	62411 62412 62413	Wages During training During holidays During sickness
	6242	62421 62422 62423	Bonus payment During training During holidays During sickness
	6243	62431 62432 62433	Employment cost National Health Insurance Graduated National Insurance Pension Superannuation
	6244	62441 62442 62443 62444 62445 62446 62447	Other payment Travelling expenses Compensation for loss of office Gratuities for dependants Ex gratia payment employees Financial aid Redundancy payment Training courses and examination fees
625		İ	Drivers and Plant Operators
	6251	62511 62512 62513	Wages During training During holidays During sickness
	6252	62521 62522 62523	Bonus payment During training During holidays During sickness
	6253	62531 62532 62533	Employment cost National Health Insurance Graduated National Insurance Pension Superannuation
	6254	62541 62542 62543 62544 62545 62546 62547	Other payment Travelling expenses Compensation for loss of office Gratuities for dependants Ex gratia payment employees Financial aid Redundancy payment Training courses and examination fees

	Dispose			Co-pro-	371
4	CHARLES - 100 CH	626		Company	Fitters
		Transmission of the Control of the C	6261	62611 62612 62613	Wages During training During holidays During sickness
			6262	62621 62622 62623	Bonus payment During training During holidays During sickness
			6263	62631 62632 62633	Employment cost National Health Insurance Graduated National Insurance Superannuation
			6264	62641 62642 62643 62644 62645 62646 62647	Other payment Travelling expenses Compensation for loss of office Gratuities for dependants Exgratia payment employees Financial aid Redundancy payment Training courses and examination fees
		627			Technicians
			6271		Wages
			6272		Bonus payment
			6273		Employment cost
			6274		Other payment
	63				Administrative Expenses
		631			Cost of communications
			6311	63111 63112 63113 63114	Postage Postage stamps "Registered envelopes "Franking machine Giro charges
			6312	631 21 631 22 631 23 631 24 631 25	Telephones County Council offices Technical staff residences Roadmen, fitters & drivers resid. Inspectors residences Clerical staff residences
			6313	63131 63132 63133	Radio Depreciation of equipment Maintenance "" Running cost ""
			6314	63141 63142 63143	Telex Depreciation of equipment Maintenance "" Running cost ""
			6315	63151 63152 63153	Radar Depreciation of equipment Maintenance " " Running cost " "

1		e			372
	632/633		Davisayaaa	100 SA	General expenses
		6321		63211 63212	Conference expenses Fees Travelling expenses
		6322		63220	Entertainment of C.C. Guests
		6323		63230	Medical examination
		6324		63241 63242	Subscriptions Societies Newspapers
		6325		63250	Computer charges
		6326		63260	Laundry
		6327			Adverts
		6328		63281 63282 63283	Fees Legal fees Consultants fees Agency Services fees
		6329			Bank charges
	634				Office equipment and furniture
		6341		63411 63412	Typewriters Depreciation Maintenance and repair
		6342		63421 63422	Calculating machines Depreciation Maintenance and repair
		6343		63431 63432	Photocopying machines Depreciation Maintenance and repair
		6349		63491 63492	Furniture Depreciation Maintenance and repair
	635				Mobile plant expenses
		6351 6352		63510 63520	Road liconce Insurance
	636	6361 6362 6363		63610 63620 63631 63632 63633	Building occupation costs Depreciation Maintenance and repairs General expenses Rent Cleaning buildings Insurance
	637				Establishment plant and equipment Depreciation
					To be classified according to existing items in the Highways Department
		1	•	-	•

	8	9	e I	373
638/639	NO. SALESTANIA SALESTA		E contraction de la contractio	Depreciation of mobile plant
	6381			Vehicles
		63811 63812	638121 638122 638123 638124	Vans Lorries 3 Ton lorries - diesel " " - petrol 5 " " - diesel " " - petrol
			638125 638126	7 " " - diesel " - petrol
		63813	638131 638132	Special gritter lorries 4 Ton lorries 7 " "
		63814 63815 63816 63817 63818 63819	638191 638192 638193	Snow plough lorries Line marking " Concrete mixer " Gully emptying " Sweeper " Trailers Low loader trailers Ordinary " Water tank "
	6382			Construction Plant
		63821	638211 638212	Excavators Excavators Loading shovels
		63822	638221 638222 638223 638224 638225 638226 638227 638228	Surfacing Sprayers - petrol engine " - hand operated Bitumen heaters Twin-burner heaters Planer Asphalt paver (Finisher) Screed spreader Pre-coated chipping spreader
		63823		Compressors and breakers
		63824		Concreting plant
		63825		Rollers and compactors
		63826		Cranes
		63829		Miscellaneous construction plant
	6393	63931 63932 63933 63934 63935 63936		Special purpose plant Gritting machines Grass mowers and attachments Pump portable Welding and cutting sets Saws Sweepers
		63939	639391 639392 639393 639394 639395 639396 639397	Miscellaneous plant and equipment Lighting generators Lighting sets Traffic control signals Line marker Tunnel shuttering equipment In-situ soil stabilisation Trailer type offices

Appendix 4

The Highways Department Annual Budget as it appears

in the County Council Annual Budget

A. The annual budget Items of expenditure Items of Income

1. Highways Department

- 1.1 Employees
- 1.2 Premises
- 1.3 Supplies and services
- 1.4 Transport
- 1.5 Establishment expenses
- 1.6 Agency services
- 1.7 Miscellaneous expenses
- 1.8 Loan charges
- 1.9 Revenue contribution to capital outlay

2. Motorways and Trunk roads

- 2.1 Maintenance
- 2.2 New construction and improvement
- 2.3 Surveys
- 2.4 Traffic census
- 2.5 "Warboys" signs
- 2.6 Lighting maintenance
- 2.7 Lighting new installation

- 1. Highways Department
 - 1.1 Local government training board contribution
 - 1.2 Miscellaneous

2. Motorways and Trunk roads

- 2.1 Reimbursement Dep. of Environ.
 - 2.1.1 Maintenance
 - 2.1.2 New construction and improvement
 - 2.1.3 Surveys
 - 2.1.4 Traffic census
 - 2.1.5 "Warboys" signs
 - 2.1.6 Lighting maintenance
 - 2.1.7 Lighting new installations.
- 2.2 Other income
 - 2.2.1 Scavenging contribution
 - 2.2.2 Miscellaneous

3. County Roads and bridges maintenance

- 3.1 Directly maintained roads
 - 3.1 Principal roads
 - 3.1.1 General maintenance
 - 3.1.2 Resurfacing
 - 3.2 Non principal roads
 - 3.2 Class II
 - 3.2.1 General maintenance
 - 3.2.2. Resurfacing

3. County Road and bridges

- 3.1 Government grant. Department of the Environment
 - 3.1.1 Principal roads
- 3.2 Contribution by British Rail and other bodies
 - 3.2.1 Principal roads
 - 3.2.2 Non principal roads
- 3.3 Rents and acknowledgements
 - 3.3.1 Principal roads
 - 3.3.2 Non principal roads

3.3 Class III

3.3.1 General maintenance

3.3.2 Resurfacing

3.2 Claimed and delegated roads

3.2.1 Principal roads

3.2.2 Non principal roads

3.2.2.1 Class II

3.2.2.2 Class III

3.2.2.3 Unclassified

3.3 Warboys Signs

3.3.1 Principal roads

3.3.2 Non principal roads

3.4 Motorways approach

special maintenance - county
council proportion

4. County Roads - improvements

4.1 Projects met out of loan

4.1.1 Loans fund expenses

4.1.2 Loan charges

4.1.2.1 Principal

4.1.2.2 Interest

4.1.3 Repayments to capital funds

4.2 Projects costing £12,500 or less

Revenue contribution to capital outlay .

4.2.1 Principal roads

4.2.2 Non principal roads

5. County roads - lighting

5.1 Establishment expenses

5.1.1 Loans fund expenses

5.1.2 Expenses - transferred loans

5.2 Agency services - rendered by other authorities operation and maintenance

5.3 Loan charges

5.3.1 Principal

5.3.2 Interest

5.3.3 Transferred loans

5.3.3.1 Principal

5.3.3.2 Interest

5.4 Revenue contributions to capital outlay

3.4 Other income

3.4.1 Principal roads

3.4.2 Non principal roads

4. County Roads Improvements

Projects costing £12,500 or less

4.1 Government grant. Department of the Environment

4.1.1 Principal loads

4.1.2 Non principal roads

4.2 Other income

4.2.1 Class III

4.2.2 Unclassified

5. County Roads - Lighting

5.1 Government grant - Department of the Environment

5.1.1 Principal roads

5.2 Other income

5.2.1 Principal roads

5.2.2 Non principal roads

6. County Roads - other Expenditure

6.1 Traffic census

6. County Roads - other Income

6.1 Traffic census

- 6.1.1 Government Department of the Environment
- 6.1.2 Contribution by other authorities
- 6.1.3 Other income

7. Rechargeable Services

- 7.1 Reinstatements
- 7.2 Private streetwork
- 7.3 Other chargeable services

7. Rechargeable services

- 7.1 Reinstatements
- 7.2 Private streetwork
- 7.3 Other chargeable services recovered.

8. Premises

- 8.1 Depot storage sites and offices
 - 8.1.1 Maintenance
 - 8.1.2 Loans fund expenses
 - 8.1.3 Loan charges
 - 8.1.4 Repayments of capital fund
- 8.2 Properties acquired for future widenings
 - 8.2.1 Maintenance
 - 8.2.2 Purchase
 - 8.2.2.1 Town and country plan
 - 8.2.2.2 Other

8. Premises

- 8.1 Depot, storage sties and offices rent
- 8.2 Properties acquired for future widening
 - 8.2.1 Government grant
 - 8.2.2 Sales
 - 8.2.3 Rents

9. Plant and equipment

- 9.1 Operating costs
- 9.2 Revenue contribution to capital
 - 9.2.1 Special motorway equipment
 - 9.2.2 Other equipment

9. Plant and equipment

9.1 Sales of old plant and equipment

10. Central Repair Depot

- 10.1 Employees
- 10.2 Premises
- 10.3 Material
- 10.4 Loan find expenses
- 10.5 Recharged from plant account
- 10.6 Recharged from Highways
 Department
- 10.7 Loan charges
- 10.8 Payment to capital fund

11. Laboratory

- 11.1 Employees
- 11.2 Premises
- 11.3 Materials
- 11,4 Soil survey
- 11.5 Vehicle maintenance
- 11.6 Telephone
- 11.7 Recharged from Highways
 Department
- 11.8 Miscellaneous

12. Other expenditure

- 12.1 National parks
- 12.2 Private streetworks
- 12.3 Training of workmen
- 12.4 Emergency roadwork
- 12.5 Local government training board levy

12. Other Incomes

- 12.1 National park and access to the countryside. Government grant.

 Department of the Environment.
- 12.2 Local government training board contribution.

Special county purposes

- 1. Road safety campaign
 - 1.1 Supplies and services
 - 1.2 Establishment expenses
 - 1.3 Agency services
 - 1.4 Miscellaneous expenses

CAPITAL EXPENDITURE BUDGET

A. The general capital expenditure

- 1. The accommodation of road construction at the division or units
- 2. The county improvement work in principal roads
- 3. The county improvement work in non principal road class II, III and unclassified.
- 4. Premises; depot, storage, offices.

B. Minor capital project

- 1. Revenue contribution to capital outlay in the department.
- 2. Project costing £12,000 or less, for principal or non principal roads
- 3. Revenue contribution to capital outlay lighting
- 4. Revenue contribution to capital outlay premises.
- 5. Revenue contribution to capital outlay special motorway equipment and other equipment

APPENDIX 5.

THE PRESENT WORTH OF £1 DUE AFTER t YEARS at 1% INTEREST - THE DISCOUNT FACTOR *

Period	5%	7%	9%	10%	11%	12%	16%	20%
1	0 . 9524	0.9346	0.9174	0.9091	0,9009	0,8929	0 . 8621	0.8333
2	0.9070	0.8734	0.8417	0.8264	0.8116	0.7972	0.7432	0.6944
3	0.8638	0.8163	0.7722	0.7513	0.7312	0.7118	0.6407	0.5787
4	0.8227	0.7629	0.7084	0,6830	0.6587	0,6355	0.5523	0,4823
5	0.7835	0.7130	0 . 6499	0,6209	0.5935	0.5674	0.4761	0.4019
6	0.7462	0,6663	0 . 5963	0.5645	0.5346	0,5066	0.4104	0.3349
7	0.7107	0.6227	0.5470	0,5132	0.4817	0.4523	0.3538	0.2791
8	0.6768	0,5820	0.5019	0.4665	0.4339	0.4039	0.3050	0.2326
9	0.6446	0.5439	0.4604	0.4241	0.3909	0,3606	0.2630	0,1938
10	0.6139	0.5083	0.4224	0.3855	0.3522	0.3220	0.2267	0,1615
11	0.5847	0.4751	0.3875	0.3505	0.3173	0.2875	0.1954	0.1346
12	0.5568	0.4440	0.3555	0.3186	0.2858	0.2567	0.1685	0.1122
13	0.5303	0.4150	0.3262	0.2897	0.2575	0.2292	0.1452	0.0935
14	0.5051	0.3878	0.2992	0,2633	0,2320	0;2046	0,1252	0.0779
15	0.4810	0.3624	0.2745	0.2394	0,2090	0.1827	0.1079	0.0649
20	0.3769	0.2584	0.1784	0.1486	0.1240	0.1037	0.0514	0.0261
25	0.2953	0.1842	0,1160	0.0923	0,0736	0.0588	0.0245	0 <u>.</u> C105
30	0.2314	0.1314	0.0754	0.0573	0,0437	0.0334	0.0116	0,0042
35	0.1813	0.0937	0.0490	0.0356	0.0259	0,0189	0.0055	0.0017
40	0.1420	0.0668	0,0318	0.0221	0.0154	0.0107	0,0026	0.0007
45	0.1113	0.0476	0.0207	0.0137	0.0091	0,0061	0.0013	0,0003
50	0.0872	0,0339	0.0134	0,0085	0.0054	0.0035	0,0006	0.0001

To four significant figures

* Discount Factor =
$$\frac{1}{(1+i)^t}$$
 = $(1+i)^{-t}$

THE DIFFERENT VALUE OF (1 - THE DISCOUNT FACTOR) at i% INTEREST.

APPENDIX 6

	5%	7%	9%	10%	11%	12%	13%	14%	15%	20%
1	0.0476	0.0654	0.0826	0.0909	0.0990	0.1071	0.1150	0.1228	0.1304	0.1667
2	0.0930	0.1266	0.1583	0.1736	0.1884	0.2028	0.2169	0.2305	0.2439	0.3056
3	0.1362	0.1837	0.2278	0.2487	0.2688	0.2882	0.3070	0.3250	0.3425	0.4213
4	0.1773	0.2371	0.2916	0.3170	0.3413	0.3645	0.3867	0.4079	0.4282	0.5177
5	0.2165	0.2870	0.3501	0.3791	0.4065	0.4326	0.4572	0.4806	0.5028	0.5981
6	0.2538	0.3337	0.4037	0.4355	0.4654	0.4934	0.5197	0.5444	0.5677	0.6651
7	0.2893	0.3773	0.4530	0.4868	0.5183	0.5477	0.5749	0.6004	0.6241	0.7209
8	0.3232	0.4180	0.4981	0.5335	0.5661	0.5961	0.6238	0.6494	0.6731	0.7674
9	0.3554	0.4561	0.5396	0.5759	0.6091	0.6394	0.6671	0.6925	0.7157	0.8062
10	0.3861	0.4917	0.5776	0.6146	0.6478	0.6780	0.7054	0.7303	0.7528	0.8385
11	0.4153	0.5249	0.6125	0.6495	0.6827	0.7125	0.7393	0.7634	0.7851	0.8654
12	0.4432	0.5560	0.6445	0.6814	0.7142	0.7433	0.7693	0.7924	0.8131	0.8878
13	0.4697	0.5850	0.6738	0.7103	0.7425	0.7708	0.7958	0.8179	0.8375	0.9065
14	0.4949	0.6122	0.7006	0.7367	0.7680	0.7954	0.8193	0.8403	0.8587	0.9221
15	0.5190	0.6376	0.7255	0.7606	0.7910	0.8173	0.8401	0.8599	0.8771	0 . 935 1
16	0.5419	0.6613	0.7481	0.7824	0.8117	0.8369	0.8585	0.8771	0.8931	0.9459
17	0.5637	0.6834	0.7689	0.8022	0.8304	0.8544	0.8748	0.8922	0.9071	0.9549
18	0.5845	0.7041	0.7800	0.8201	0.8472	0.8700	0.8892	0.9054	0.9192	0.9624
19	0.6043	0.7235	0.8055	0.8365	0.8623	0.8839	0.9019	0.9171	0.9297	0.9687
20	0.6231	0.7416	0.8216	0.8514	0.8760	0.8963	0.9132	0.9272	0.9389	0。9739
21	0.6411	0.7585	0.8363	0.8649	0.8883	0.9074	0.9232	0.9362	0.9469	0.9783
22	0.6582	0.7743	0.8491	0.8772	0.8993	0.9174	0.9320	0.9440	0.9538	0.9819
23	0.6744	0.7891	0.8622	0.8883	0.9093	0.9262	0.9399	0.9509	0.9598	0.9849
24	0.6899	0.8029	0.8736	0.8985	0.9183	0.9341	0.9468	0.9569	0.9651	0.9874
25	0.7047	0.8158	0.8840	0.9077	0.9264	0.9412	0.9529	0.9622	0.9696	0 . 985 1

To four significant figures.

APPENDIX 7

THE CAPITAL RECOVERY FACTORS * FOR £1 DUE AFTER t YEARS at i% INTEREST

	5%	8%	9%	1C%	11%	12%	14%	16%	20%
1	1。0500	1.0800	1.0900	1.1000	1.1100	1.1200	1.1400	1.1600	1.2000
2	0.5378	0.5608	0.5685	0.5762	0.5839	0.5917	0.6073	0.6230	0.6545
3	0.3672	0.3880	0.3951	0.4021	0.4092	0.4163	0.4307	0.4453	0.4747
4	0.2820	0.3019	0.3087	0.3154	0.3223	0.3292	0.3432	0.3574	0.3863
5	0.2310	0.2505	0.2571	0.2638	0.2706	0.2774	0.2913	0.3054	0.3344
6	0.1970	0.2163	0.2229	0.2296	0.2364	0.2432	0.2572	0.2714	0.3007
7	0.1728	0.1920	0.1987	0.2054	0.2122	0.2191	0.2332	0.2476	0.2774
8	0.1547	0.1740	0.1807	0.1874	0.1943	0.2013	0.2156	0.2302	0.2606
9	0.1407	0.1601	0.1668	0.1736	0.1806	0.1877	0.2022	0.2171	0.2481
10	0 .1 295	0.1490	0 .1 558	0.1627	0.1698	0.1770	0.1917	0.2069	0.2385
11	0.1204	0.1400	0.1469	0.1540	0.1611	0.1684	0.1834	0.1989	0.2311
12	0.1128	0.1327	0.1397	0.1467	0.1540	0.1614	0.1767	0.1924	0.2253
13	0.1065	0.1265	0.1336	0 .1 408	0.1482	0.1557	0.1712	0.1872	0.2206
14	0.1010	0.1213	0.1284	0.1357	0.1432	0.1509	0.1666	0.1829	0.2169
15	0.0963	0.1168	0.1241	0.1315	0.1391	0.1468	0.1628	0.1794	0.2139
20	0.0802	0.1019	0.1095	0.1175	0.1256	0.1339	0.1510	0.1687	0.2054
25	0.0710	0.0937	0.1018	0.1102	0.1187	0.1275	0.1455	0.1640	0.2021
30	0.0651	0.0888	0.0973	0.1061	0.1150	0.1241	0.1428	0.1688	0.2008
35	0.0611	0.0858	0.0946	0.1037	0.1129	0.1223	0.1414	0.1609	0.2003
40	0.0583	0.0839	0.0930	0.1023	0.1117	0.1213	0.1407	0.1604	0.2001
45	0.0563	0.0826	0.0919	0.1014	0.1110	0.1207	0.1404	0.1602	0.2000
50	0.0548	0.0817	0.0912	0.1009	0.1106	0.1204	0.1402	0.1601	0.2000
		·							

To four significant figures

APPENDIX 8

THE USE OF CRITICAL PATH METHOD AND BAR CHART IN PLANNING, PROGRAMMING AND RESOURCE LEVELLING OF AN IMPROVEMENT PROJECT

The project consists of seven events with eleven activities, two of which are dummies. The network diagram of this project is illustrated in Figure A.8.1. The time required to complete each activity is plotted against each activity in the diagram. The earliest and latest start for each event can be calculated by using a simple matrix in the following manner:

E.EV	j	1	2	3	4	5	6	7
0	1		7	6	15		4	
7	2					4		
6	3					2	0	
15	4					0		8
15	5							5
6	6							4
23	7							
L.EV		0	14	16	15	18	19	23

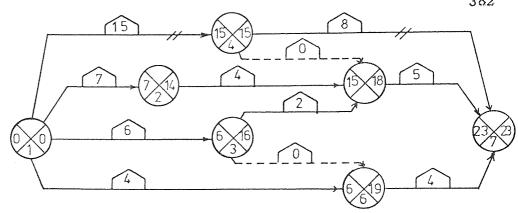


FIGURE A.81 PROJECT NETWORK SHOWING DURATIONS.

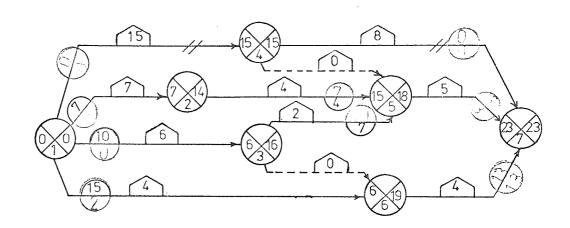


FIGURE A.8.2 PROJECT NETWORK SHOWING DURATIONS AND FLOATS.

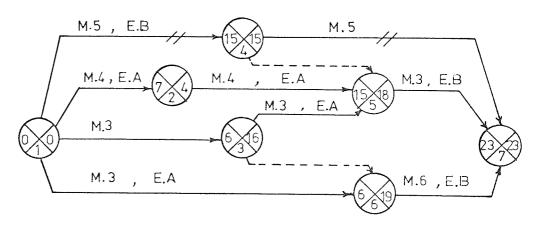


FIGURE A 8.3 PROJECT RESOURCES MANPOWER AND EQUIPMENT.

CRITICAL PATH
DURATION
TOTAL FLOAT

FREE FLOAT

M NUMBER OF MEN

E TYPE OF EQUIPMENT

Event	Calculation		Event	Calculation	L.EV
1	zero	0	7	23	23
2	0 + 7	7	6	23 - 4	19
3	0 + 6	6	5	23 - 5	18
4	0 + 15	15	4	23 - 8, 18 - 0	15
5	7 + 4, 6 + 2, 15 + 0	15	3	19 - 0, 18 - 2	16
6	0 + 4, 6 + 0	6	2	18 - 4	14
7	15 + 8, 15 + 5, 6 + 4	23	1	19 - 4, 15 - 15, 16 - 6, 14 - 7	0

The earliest tail and latest head event times form boundaries within which activities are able to move. The time available for an activity in relation to its duration within these boundaries is called 'float', which can appear as -

- a) <u>Independent float</u>: This is the time by which an activity can expand without affecting either previous or subsequent activities.
- b) Free float: This is the time an activity can expand without affecting subsequent activities. If it is absorbed at the planning stage, the float in earlier activities will be reduced. When a project is underway, the free float in an activity can be used once the tail event is reached, without affecting other activities in the network.
- c) Negative float: This is the time by which an activity must be reduced for the project to meet the target date.
- d) <u>Total float</u>: This is the time by which an activity can expand. When total float is absorbed at the planning stage, the float in both previous and subsequent activities may be reduced.

The floats of this project can be calculated by using a table of activity times and floats, which should be prepared as follows:

i - j	DUR	START		FINISH		SLACK		FLOATS		
	-	Early	Late	Early	Late	Tail	Head	Total	Free	Indp
1 - 2	7	0	7	7	14	0	7	7	0	0
1 - 3	6	0	10	6	16	0	10	10	0	0
1 - 4	15	0	0	15	15	0	0	0	0	0
1 - 6	4	0	15	4	19	0	13	15	2	2
2 - 5	4	7	14	11	18	7	3	7	4	0
3 - 5	2	G	16	8	18	10	3	10	7	0
3 - 6	0	6	19	6	19	10	13	13	0	. 0
4 - 5	0	15	18	15	18	0	3	3	0	0
4 - 7	8	15	15	23	23	0	0	0	0	0
5 - 7	5	15	18	20	23	3	0	3	3	0
6 - 7	4	6	19	10	23	13	0	13	13	0

NOTE: (1)

- 1. A different expression of the ability of activities to move is given by considering the head and tail events in the <u>net-work</u>. These have 'earliest' and 'latest' times, and slack is the difference between these times.
- 2. <u>Total float</u>: Difference between early finish time of an activity and the latest time of the head event.
- 3. Free float: Difference between total float and head slack.
- 4. <u>Independent float</u>: The difference between free float and tail slack.
- 5. The latest start time of an activity does not necessarily coincide with the earliest time of its tail event; such coincidences only apply to activities on the critical path.

 Thus the start and finish time in the table cannot be read directly from the diagram, but must be derived from the table.
- 6. The term slack is used as referring only to an event.

British Standard Institution "Glossary of Terms used in Project Network Techniques". B.S. 4335. 1972.

7. The Critical Path in a network is that path which has least float.

The importance of knowing the type of float depends upon the use made of the information - for example, if it is desired to reduce the effort in the non-critical activity, then independent floats can be used without replanning any other activity. On the other hand, free floats can be used without affecting subsequent activities. The available floats calculated for this project are shown in the network diagram Figure A.8.2.

Road-men and equipment required for each of the project activities, and which determine the resources needed for each duration, are shown in Figure A. 8.3., where activity 1-4, for instance, requires 5 men plus equipment B for its duration of 15 days, whereas activity 1-3, needs a workforce of 3 men only, and so on. It is also seen that equipment A and B is individually required for separate activities. There are many possibilities for scheduling the non-critical activities within the limits imposed by the network diagram and the resources available. Each possibility selected implies a definite rate of application of resources, manpower and equipment and of consumption of the necessary materials.

One obvious schedule is to begin every activity as soon as possible. This earliest start schedule is presented in Figure A.8.4. In the table a separate row is used for each resource needed by each activity. Free float time appears as the time gap between the last scheduled day for a chain of activities and the determining event time for that chain. All activities are scheduled for their normal duration; no float is scheduled for any particular activity, and therefore, free float becomes a future safety margin only. This schedule requires a definite daily application of resources as included in the bottom of the tabulation; the work force varies from 5 men, to a maximum of 17 men; equipment A is used for 11 days, with two sets being required for 6 days, whereas equipment B is required for 20 days with two sets being required for four days.

Another schedule is starting each activity as late as possible. This latest start schedule appears in Figure A.8.5. The rate of application of resources is plotted as 'latest start'. The work force varies from 5 men to 15. Equipment A is required for 12 days, with two sets being used one day and three sets being used two days. Equipment B is required

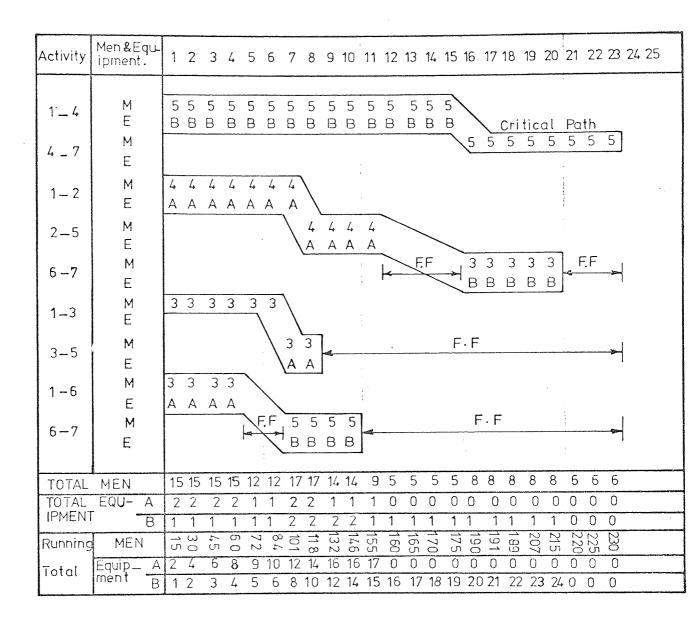
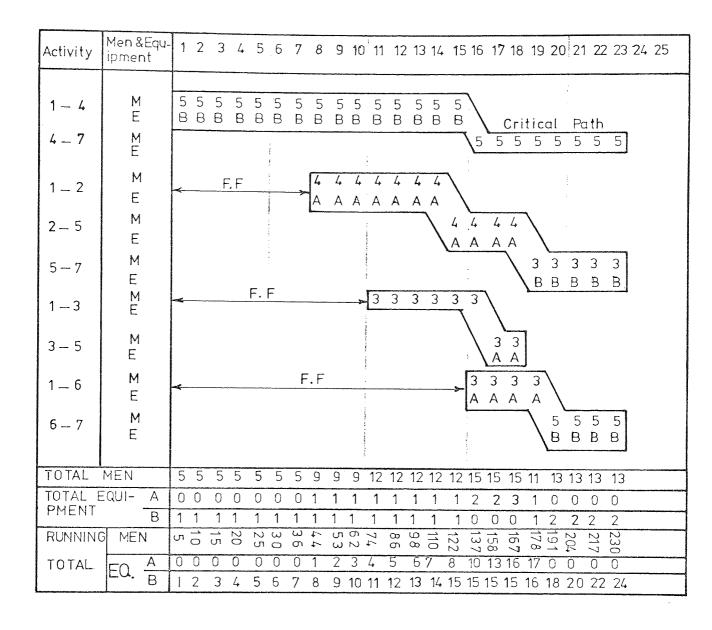


FIGURE A.8.4 EARLIEST START SCHEDULE



FIGUREA.8.5 LATEST START SCHEDULE

for 20 days, separated by a 3-day stand-down; with two sets being used for four days. It will be seen from the table that all floats are discarded and hence all chains become critical; with the schedule a delay in any activity delays the project completion.

An important factor in scheduling, which is not included in this example is the classification of activities into two groups — continuous or intermittent (splittable). When a continuous operation activity is started, it must be worked without interrupation until finished; and intermittent operation activity can proceed piecemeal in isolated sections at irregular period of time. This division becomes vital when a choice is to be made whether it is advantageous to do part of an activity at a particular time and the balance later.

Use of Floats in Activity Shifting for Resource Levelling

It will be obvious that the compromise between these two schedules (earliest and latest start) for the project, should result in a more constant work force over the whole project duration and a more efficient use of equipment A and B.

The procedure of resource levelling is shown in Figure A.8.6. Here the managerial constraint adopted is to give first preference to the levelling out of the equipment required, and second to maintain a fairly constant labour force. (It is possible to reverse this strategy). The critical activities (having no float) must be scheduled first since their event times are fixed. The tabulation is, therefore so presented that chains of activities are considered in order of increasing float.

The resources required of the critical activities 1-4 and 4-7 are thus recorded first in the first rows of Figure A.8.6. Next are the non-critical chains, which may occur at any time within the limitation of their available float, ie. their starting and finishing dates are adjustable in the programme anywhere within the range between the timing of their initial and final event provided their durations are not altered. This moving of activity times, within the range of their available floats, is called "Activity Shifting" and is the essential procedure for 'resource levelling'.

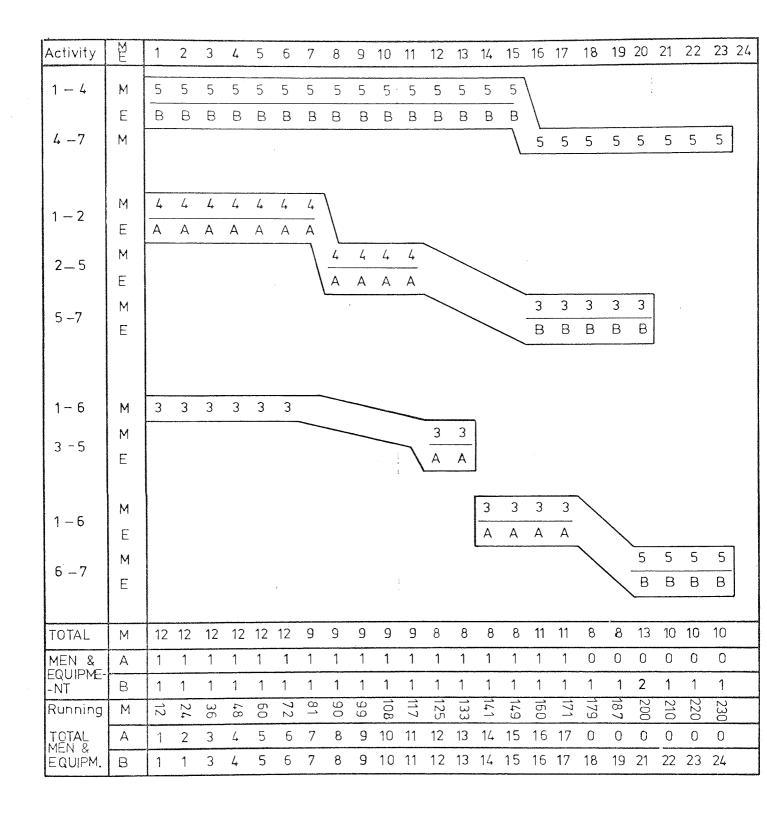


FIGURE A 8.6 SCHEDULE FOR MINIMUM EQUIPMENT AND MEN.

As a result of the activity shifting according to the above procedures, the work force varies from 8 men to 12, and 13 men being required for one day. Equipment A is required continuously for 17 days, and equipment B is required continuously for 23 days, which is the project duration, with two sets being required for only one day. (2) This compromise schedule therefore almost satisfies the ideal situation and still provides for unforseen delays. The levelling of resources has been well worthwhile.

With resource levelling of large projects, it is helpful to tabulate the separate labour skills and plot the manpower required for each against time, this may be done when the original schedule is revised and amended. A similar plot may be prepared for each item of equipment. The procedure is somewhat complicated because of the inter-relations between activities, but the effort is amply rewarded by the production of detailed worked schedules in which problems of labour and equipment are overcome as far as possible. In chains of activities involving numerous operations, with various labour requirements and skills and different types of equipment, the most satisfactory way of carrying out detailed resources levelling is to begin with the labour skill (or major equipment item) having the greatest fluctuations. Smoothing this out first, without regard to other skills or equipment, one then proceeds with a second skill (or piece of equipment), and so on, one skill (or machine) at a time, until a satisfactory overall labour and equipment balance is obtained. With complex chains the same skill or equipment may have to be reviewed several times and relevant activities shifted, and reshifted before an acceptable solution appears. As pointed out, the best approach is first to shift those activities with a small float and then those with a large float.

In drawing up the tabulation, before beginning resource levelling, it is helpful to draw a sequenced Gantt chart for the project, this will ensure not making incompatible decisions during the activity shifting procedure, especially when reshifting is found necessary.

The project duration may be exceeded by one day to reduce the need for another set of plant.

APPENDIX 9

PLANT CALCULATION FOR DECISION MAKING

The repair depot central office should ensure that all items of plant are fully utilized not only by means of allocating the county's own plant to different operations, but also during their period on sites. This can be achieved by ensuring that the optimum type and number of plant items are allocated to the appropriate operation during the planning of projects. The office should also ensure that the cost of plant recommended to be used in carrying out the work is the lowest cost - assuming that the items of plant are available in the central repair depot and/or for hiring without leaving County Council plant idle, and there is no technical objection from the engineers. The following are a number of examples which may help in determining the type and number of plant to be used in executing the work in the Highways Department.

Example No. 1

The operation is earth work operation and involves excavating and hauling $49300~\text{m}^3$ of good common earth. There are two alternatives involving the item of plant to be used to carry out the operation. In the second alternative a small bulldozer is used to improve lorry access to the shovel and maintain the haul road. This should reduce the swing angle and round trip times.

	1st alternative	2nd alternative
Item of Plant	One 0.6 m power shovel Five 3.0 m ² lorries	One 0.6 m ³ power shovel Five 3.0 m ³ lorries, one small bull-dozer
Shovel depth	2.6 m	2.1 m
Shovel angle of swing	120°	75 ⁰
Job condition	Fair	Good
Shovel operate	42 min/hr	45 min/hr
Lorry operate	45 min/hr	50 min/hr
Round trip time of one lorry	15 mins	12 mins
Management condition	Good	Good
Cost of shovel	£4.60/hr	£4.60/hr
Cost of each lorry	£1.90/hr	£1.90/hr
Cost of dozer		£2.00/hr
Bonus for production excess of the first alternative		£0.01/m ³

By using the following tables which have been prepared by the Power Crane and Shovel Association of America, the following calculation can be carried out to determine the cheapest alternative, and accordingly, the number and type of plant to be included in the resources required for the operation.

The First Alternative

Size of power shovel 0.6 m 3 in good common earth, using table 1, the ideal output = 103 m 3 /hr opt. depth = 2.1 m

2.6 m Depth of cut 120° Angle of swing Job condition Good Management condition Fair $42 \min/hr$ Shovel operates Percentage of optimum/ actual depth x 100 depth optimum depth $2.6 \times 100 =$ 123.89% = 124% $\frac{1}{2.1}$

I DEAL OUTPUTS OF POWER SHOVELS MP TAB. 1*

in cubic metre per hour bank measure.

CLASS OF				SIZI	E OF SI	HOVEL	(cum)		
MATERIAL	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.6	2.0
woist loam or sandy clay	1.2 65	1.4 88	1.ô 126	1.8 157	2.0 191	2.1 218	2.3 245	2.4 272	2. õ 310
sand and gravel	1.2 61	1.4 84	1.6 118	1.8 153	2.0 176	2.1 207	2.3 229	2.4 253	2.6 298
good common earth	1.4 54	1.7 73	2.1 103	2.4 134	2.6 161	2.8 184	3.0 206	3.1 230	3.4 268
hard tough clay	1.8 38	2.1 57	2.4 84	2.7 111	3.0 138	3.3 161	3.5 180	3.7 203	4.1 237
well blasted rock	31	46	73	96	119	138	157	176	210
wet sticky clay	1.8	2.1 31	2.4 54	2.7 73	3.0 92	3.3 111	3.5 126	3.7 141	4.1 176
poorly blasted rock	11	19	38	5 7	73	115	107	122	149

Note - 1.2 etc are the optimum depths of cut in metres.

CONVERSION FACTORS FOR DEPTH OF CUT AND ANGLE OF SWING FOR POWER SHOVELS*

PERCENTAGE OF	ANGLE	OF SWI	NG IN D	EGREES			
OPTIMUM DEPTH	45	60	75	90	120	150	180
40	0.93	0.89	0.85	0.80	0.72	0.65	0.59
60	1.10	1.03	0.96	0.91	0.81	0.73	0.66
80	1.22	1.12	1.04	0.98	0.86	0.77	0.69
100	1.26	1.16	1.07	1.00	0.88	0.79	0.71
120	1.20	1.11	1.03	0.97	0.86	0.77	0.70
140	1.12	1.04	0.97	0.91	0.81	0.73	0.66
160	1.03	0.96	0.90	0.85	0.75	0.67	0.62
180	0.93	0.87	0.82	0.78	0.68	0.59	0.54

FACTORS FOR JOB AND MANAGEMENT CONDITIONS*

JOB	MANA	GMENT COND	TTIONS	
CONDITIONS	EXCELLENT	GOOD	FAIR	POOR
EXCELLENT	0.84	0.81	0.76	0.70
good	0.78	0.75	0.71	0.65
fair	0 .7 2	0.69	0.65	0.60
poor	0.63	0.61	0.57	0.52

* The Power Crane and Shovel Association of America.

Depth/swing factor = 0.86 from table (2)

Job/Management

factor = 0.71 from table (3)

Lost time factor = $1 - \frac{\text{Percentage of idle time}}{100}$

= 1 - 0.30 = 0.70

Probable output Ideal output x depth/swing factor x job/management factor x lost time factor

= $103 \times 0.86 \times 0.71 \times 0.70 = 44.02 \text{ m}^3/\text{hr}$.

Lorries

Size of lorries = 3.0 m^3 round trip = 15 mins.

Operating time/hr. 45 min/hr

Probable output of lorry/hr = No. of cycles per/hr. x capacity

 $= \frac{45 \times 3}{15} = 9 \,\mathrm{m}^3/\mathrm{hr}$

Actual output of 5 lorries = 9×5 = $45 \text{ m}^3/\text{hr}$

Probable output = $\frac{44.02}{m}$ m³/hr

Costs

Cost of shovel = £4.60

Cost of lorries $(5 \times 1.90) = £9.50$

£14.10

 $\frac{14.10}{44.02} = \underbrace{£0.320/m}^{3}$

The Second Alternative

Using a small dozer to increase efficiency

Size of shovel = 0.6 m^3 Ideal output = 103

Opt/depth in good common earth = 2.1 m

Angle of swing = 75°

Job condition = Good

Management condition = Good

Lost time = 15 mins

Percentage of optimum depth = $\frac{2.1}{2.1}$ x 100 = 100%

Depth/swing factor = 1.07

Job/Management factor = 0.75

Lost time factor = 1 - 0.15 = 0.75

Probable output = $103 \times 1.07 \times 0.75 \times 75 = 61.99 \text{ m}^3/\text{hr}$

Lorries

Size of lorry $= 3 \text{ m}^3$

Round trip time = 12 mins

Operating time/hr = 50 mins

No of cycles/ hr = $\frac{50}{12}$ = 4.166 = 4.17

Output per lorry/hr = $3 \times 4.17 = 12.51 \text{ m}^3$

Using 5 lorries = $12.51 = 62.55 \,\mathrm{m}^3/\mathrm{hr} > 61.99$

The probable output (shovel output) = $\frac{61.99}{}$ m³/hr

There is no need for an extra lorry as the optimum efficiency of using 5 lorries = $\frac{61.99}{68.55}$ x 100 = 99.1/hr

Costs

Cost of one shovel = £4.60

Cost of lorries $5 \times 1.90 = £9.50$

Cost of one dozers = £2.00

Bonus $(61.99-44.02) \times 0.01 = £0.18$

£16.28

 $\cos t/m^3 = \frac{\cos t/hr}{\Pr{ch} \quad \text{output}} = \frac{16.28}{61.99} = \frac{\text{£0.263/m}^3}{\text{}}$

The reduction in cost using Alternative 2 /m³ = 0.320 - 0.263 = £0.057 m³

The net saving in the operation = 0.057 x 49300 = £2810.1

Therefore it is recommedned to use method 2 which necessitates the us of an extra dozer and the same number of lorries.

Example 2

Using the same tables, it is required in this example to select a suitable sized shovel that will excavate 76500 m^3 of sand and gravel in 125 days (1 day = 8 hrs). Excavating depth 2.5m, seing angle 150° , lost time is 25%, and job and management conditions are both good.

Amount to be ecavated, 76500 m^3 sand and gravel in 125 days of $76.5 \, \text{m}^3/\text{hr}$ 76500 Probable output required 125 x 8 2.5 m Excavated depth 150° Angle of swing = Good Job condition Management condition Good 25% Lost time Depth/swing factor = 0.75 (Average - guess as the percentage of optimum depth is unknown) Job/Management factor = 0.75Cost time factor = 1.0 - 0.25 = 0.75Ideal output required = Probable output D/S Factor x J/M factor x L/T factor $= 181.27 \text{m}^3/\text{hr}$

From table 1, a 1.0 m shovel has an ideal output of 176 m 3 /hr < 181.27 m 3 /hr and a 1.2 m 3 shovel, excavating in sand and gravel, has an ideal ouput of 207 m 3 /hr > 181.27 m 3 /hr and an optimum depth of 2.1 m, therefore we should try 1.2m 3 shovel.

Percentatge of optimum depth = $\frac{2.5}{2.1}$ x 100 = 119%

= 150° Angle of swing

= 0.77Depth/swing factor

> $= 207 \times 0.77 \times 0.75 \times 0.75$ Probable output

 $= 89.6 \text{ m}^3/\text{hr} > 76.5 \text{ m}^3/\text{hr}$

Adopt 1.2 m shovel for this operation

Example 3

In this example, the calculation helps in determining the most economical size of lorries to be used for transporting materials from one place to another, i.e. transporting filling materials from one place to pits and sites, or transporting mixed materials from the mixers to site. This should ensure that the paver finisher on site or the shovel in the quarry is kept fully utilised and is maintaining the output of the lorries.

If the work in the operation is carried out by one shovel with a probable output of lll m hr, and it is required to determine the most economical number of lorries to be used in the operation if the size of the available lorries is 4.5 m^3 , the round trip is 15 mins., and the operating time is 50 min/hr.

The shovel cost £7.38/hr., the lorry cost £2.70/hr.

The economical number of lorries can be calculated as follows:-The probable output of lorries

= number of cycles per/hr. x capacity

$$=\frac{50}{60}$$
 x 4.5 = 15 m³/hr.

and in order to match shovel and lorries output the number of lorries required

the probable output of shovel the probable output of one lorry

A comparison should be made between the cost of using 7 and 8 lorries.

		Using 7 lorries	Using 8 lorries
Actual output	7 x 15	$= 105 \text{ m}^3/\text{hr}$	111 m ³ /hr
Optimum efficiency for shovel	105 x 100	= 95%	100%
Optimum efficiency for lorry		= 100%	$\frac{111}{8.15}$ x 100 = 92%
Cost			
Shovel		£7.38	£ 7.38
Lorry	7 x 2.70	= £18.90	$8 \times 2.70 = £21.60$
		£26.28	£28.98
Cost per cu/m	$\frac{26.28}{111}$	= 0.2367	$\frac{28.98}{111} = 0.2610$

From this comparison it is clear that it will be more economical to use seven lorries in this operation.

This type of calculation can also be used in comparing the cost of using different types of lorries with different costs.

Example 4

In this example the application of the theory of queues is ued to determine the most economical number of lorries to be used in an operation such as the previous one. Generally, queuing problems fall into two broad groups. (1)

(a) Those in which the arrivals in the queue do not appear at regular times. In this case, it is necessary to determine the optimum facilities which are necessary in order to deal with the probable worst case.

Alternatively, it is necessary to arrive at an economic solution for the establishment of facilities.

R PILCHER. "Principal of Contruction Management for Engineers and Managers" (London, McGraw Hill Publishing Co Ltd. 1966) p328

(b) Those in which the facilities are fixed in number, such as in a machine shop, where there are a fixed number of lathes, the problem is that of assessing the optimal programme for the arrival of work to be allocated to the fixed facilities.

The general solution to these types of problems can be either analytical or by the use of simulation techniques using the facilities or a computer. It is also prossible to simulate the problem without using the computer in the case of simple single channel single server queues.

The use of this technique necessitates the help of the central repair work study office, which should produce frequency/time curves and, hence, cumulative probability distribution curves for a varying shovel load time, and varying combined travel, deposit and return times for the lorries. It is also necessary to use tables of random numbers, and it is important that each entity (shovel, lorry etc.) should have its own stream of random numbers to facilitate comparative studies.

Assume that the simulation problem is as follows:-

Using the following values of hourly costs for lorries and excavator etc., compare the cost of excavating and transporting materials from the barrow pit to the road fill area, using either five or six lorries -

Cost of shovel = £5.00 h⁻¹

Cost of one lorry = £3.50 h⁻¹

Loading time for one lorry (average) = 3 mins.

Travel, deposit and return time for 1 lorry (average) = 15 mins.

Lorry capacity = 4.6 m³

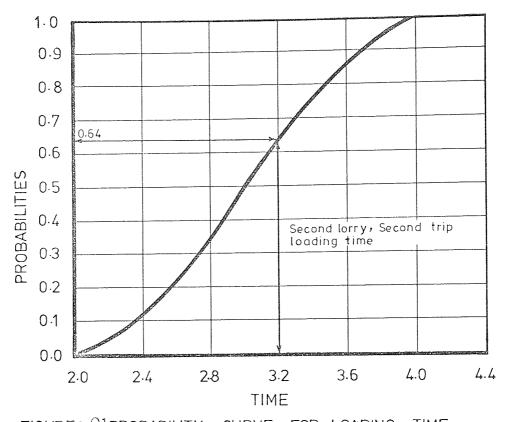
and the random numbers which are used in the calculations are as the following:-

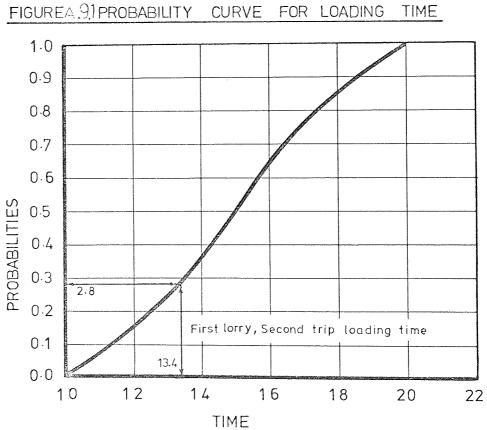
1	2	3	4	5	6	7	8	9	10
2	8	8	9	6	5	8	. 7	0	8
3	0	2	9	4	3	6	5	4	2
9	5	7	4	6	2	6	0	5	3
0	1	8	5	5	4	9	6	7	2
1	0	9	1	4	6	9	6	8	6
0	5	3	3	1	8	0	8	5	1
0	4	4	3	1	3	3	7	0	0
0	5	8	9	4	0	2	5	2	4
8	4	9	О	9	0	6	5	7	7
2	8	5	5	5	3	О	9	4	8
8	9	8	3	4	О	6	9	8	0
7	3	2	О	9	6	О	5	6	8
1	0	8	9	0	7	7	6	2	1
9	1	5	О	2	7	7	8	3	7
0	3	4	5	4	4	6	4	8	8
		! !	İ	1	1			1	1

NOTES:

- (1) Columns 1 & 2 will be used for the first lorry. Columns 2 & 3 will be used for the second lorry etc.
- (2) Columns 7 & 8 will be used for load time estimates.
- (3) The random figures will be used to obtain samples of the travelling and loading times when using the work study curves.

Assume that the work study office presents the following curves, Figures A9A and A9.2, as the ideal cumulative probability distribution for loading, traveeling, deposit and return:-





FIGUREA. 9.2 PROBABILITY DISTRIBUTION CURVE FOR TRAVEL, DEPOSIT & RETURN TIME

Cycle No.	Truck	R.F	Travel time	Arriv.	Admit to shv.	R.F	Load time	Depart shvl	Wait time	Queue time	Queue Size
1	1			0.0	0.0		3.0	3.0	3.0	0.0	4
	2			0.0	3.0		3.0	6.0	6.0	3.0	3
	3			0.0	6.0		3.0	9.0	9.0	6.0	2
	4			0.0	9.0		3.0	12.0	12.0	9.0	1
	5			0.0	12.0		3.0	15.0	15.0	12.0	0
2	1	28	13.4	16.4	16.4	87	3.6	20.0	3.6	0.0	0
	2	88	18.3	24 • 3	24 • 3	65	3•2	27.5	3•2	0.0	. 0
	3	89	18.4	27 • 4	27.5	60	3•2	30.7	3•3	0.1	1
	4	96	19.3	31.3	31•7	96	3•9	34 • 6	2•9 7•2	0•4 3•3	0
	5 *	65	16.0	$\binom{31.3}{31.0}$	34 • 6	96	3•9	38.5	7•5	3 • .6	1
3	1	30	13.6	33•6	38•5	08	2•3	40.8	7•2	4•9	2
	2	02	10.2	37•7	40.8	37	2•8	43.6	5•9	3•1	3
	3	29	13•5	44•2	44•2	25	2•7	46.9	2•7	0.0	0
	4	94	19•1	53.7	53•7	65	3•2	56•9	3•2	0.0	0
	5 *	43	14.6	53.7 53.1	56.9	09	2.3	59•2	5•5 6•1	3•2 3•8	1
4	1	95	19.2	60.0	60.0	69	3•3	63•3	3•3	0.0	0
	2 *	57	15.5	60.0 59.1	63•3	05	2•2	65.5	5 • 5 6 • 4	3•3 4•2	1
	3	74	16.8	63•7	65.5	76	3•4	68.9	5•2	1.8	1
	4	46	14.8	71.7	71.7	78	3•4	75•1	3•4	0.0	0
	5	62	15.8	75.0	75 • 1	64	3•2	78•3	3•3	0.1	1
5	1 *	01	10.1	$\begin{cases} 75.0 \\ 73.1 \end{cases}$	78.3	70	3•3	81.6	6•6 8•5	3•3 5•2	2
	2	18	12.3	77•8	81.6	54	3.0	84•6	6.8	3•8	0
	3	85	17.9	86.8	86.8	05	2•2	89.0	3•2	0.0	0
	4 *	55	15.4	86.8 80.5	89.5	67	3•2	92•7	5•9 12•2	2•7 9•0	1
	5	54	15•3	93•6	93.6	68	3.1	96.7	3.1	0.0	0
6	1 *	10	11•3	93•6 92•9	96.7	85	3•6	100.3	6.7 7.4	3.1 3.8	1
	2	09	11.1	95•7	100.3	70	3•3	103.6	7•9	4.6	2
	3	91		107.6	107.6	52	3.0	110.5	2•9	0.0	0
	4 *	14	11.8	107.6	110.6	57	3.1	113.7	6.1 9.2	3.0 6.1	1
	5	46	14.8	111.5	113.7	94	3•8	117.5	6.0	2•2	1

NOTE.

- A. The first five inter-arrival intervals and lead times are assumed to be constant at 3 minutes.
- B. Lorries marked (*) are constrained to form moving queues as overtaking is not allowed.

(No 1. Simulation: - 1 shovel; 5 trucks).

Ignoring the first cycle in No.1 simulation =
The time needed to shift four cycles =

Lorry	No.	1	96.7 - 16.4	80.3 mins
**	11	2	100.3 - 24.3	76.0
11	11	3	107.6 - 27.5	80.1 "
11	11	4	110.6 - 13.7	78.9 "
11	91	5	113.7 - 34.6	79.1 "

Total: 394.4 "

Average cycle time for one lorry = $\frac{394.4}{4 \times 5}$ = 19.72 mins.

Thus, the revised output of each lorry will be -

$$\frac{60 \times 4.5}{19.72} = \frac{13.69 \text{ m}^3/\text{hr}}{}$$

Comparing with the original output of

$$\frac{50 \times 4.5}{15} = \frac{15.0 \text{ m}^3/\text{hr.}}{}$$

Costs

Cost of shovel = £5.00

Cost of lorries 5 x 3.5 = £17.50

Total flat cost: £22.50

$$\cos t/m^3 = \frac{22.50}{13.69 \times 5} = £0.328$$

Cycle	Truck No•	R.F	Travel time	Arriv.	Admit to shvl	R.F	Load time	Depart shvl	Wait time	Queue time	Queue size
1	1 2 3 4 5 6			0.0 0.0 0.0 0.0	0.0 3.0 6.0 9.0 12.0		3.0 3.0 3.0 3.0 3.0	3.0 6.0 9.0 12.0 15.0 18.0	3.0 6.0 9.0 12.0 15.0 18.0	0.0 3.0 6.0 9.0 12.0 15.0	5 4 3 2 1
2.	1 2 3 4	28 88 89 96	13.4 18.3 18.4 19.3	16.4 24.3 27.4 31.3	18.0 24.3 27.5 31.3	87 65 60 96	3•6 3•2 3•2 3•9	21.6 27.5 30.7 35.2	5.2 3.8 3.3 3.9 7.8	3.0 0.0 0.1 0.0 3.9	1 0 1 0
	5 6	65 58	16.0 15.6	31.0	35•2 39•1	96 08	3•9 2•3	39•1 41•4	9•1 7•8	4 • 2 5 • 5	2
3	1 2 3 4	30 02 29 94	13.6 10.2 13.5 19.1	35 · 2 37 · 7 44 · 2 54 · 3	41.4 44.2 46.9 54.3	37 25 65 09	2.8 2.7 3.8 2.3	44.2 46.9 50.1 56.6	9.0 9.2 5.9 2.3 5.6	6.2 6.5 2.7 0.0 2.3	2 3 1 0
	5 6	43 36	14.6	54•3 53•7 55•5	56•6 59•9	69 05	3•3 2•2	59•9 62•1	6.2 6.6	2.9	1 2
4	1 2 3 4 5	95 57 74 46 62 26	19.2 15.5 16.8 14.8 15.8	63.4 63.4 62.4 66.9 71.4 75.7 75.7	63.4 66.8 70.2 73.4 76.7	76 78 64 70 54	3.4 3.4 3.2 3.3 3.0	66.8 70.2 73.4 76.7 79.7 81.9	3.4 6.8 7.8 6.5 5.3 4.0 6.2 6.6	0.0 3.4 4.4 3.3 2.0 1.0 4.0 4.4	0 1 1 1 1 1 2
5	1 2 3 4 5 6	01 18 85 55 54 49	10.1 12.3 17.9 15.4 15.3 14.9		81.9 85.1 91.3 94.9 98.2 101.2	67 68 85 70 52 57	3.2 3.1 3.6 3.3 3.0 3.1	85.1 88.2 94.9 98.2 101.2 104.3	8·2 5·7 3·6 6·1 6·2 7·5	5.0 2.6 0.0 2.8 3.2 4.4	2 1 0 1 1
6	1 * 2 3 * 4 * 5 6	10 09 91 14 46	11.3 11.1 18.6 11.8 14.8	96.8 96.4 99.3 113.5 113.5 110.0 116.0	104.3 108.1 113.5 116.6 119.8	94 98 56 62 83	3.8 3.9 3.1 3.2 3.5	108.1 112.0 116.6	11.3 9.7 12.7 3.1 6.3 9.8	7.5 5.9 8.8 0.0 3.1 6.6	2 3 0
	6	69	16.3	120.6	123.3	48	3.0	123.3	7 · 3 5 · 7	3.8 2.7	2

No 2. Simulation: - 1 shovel; 6 trucks.

Ignoring the first cycle for No. 2 simulation The time needed to shift four cycles =

Total: 510.2 "

The cycle time for one truck =
$$\frac{510.2}{4 \times 6}$$
 = 21.258 mins.
= $\frac{21.26}{10.2}$ "

Thus the revised output will
be
$$\frac{60 \times 45}{21.26} = \frac{12.699}{10.26}$$
 "

Comparing with the original output of
$$\frac{12.7 \text{ m}^3/\text{hr}}{14.998 \text{ m}^3/\text{hr}}$$

Costs

Cost of shovel = £5.00

Cost of lorries 6 x 3.5 = £21.00

$$\frac{£26.00}{12.7 \times 6} = £0.341$$

It is better to use 5 lorries, with $cost/m^3$ $\frac{£0.328}{£0.341}$

This type of calculation should help in determining the number of lorries to be used in the operation and the methods of carrying out the work in the different improvement operations. Alternatively, estimating charts could be prepared as a result of computerised simulation studies of a wide range of typical earth-moving systems.

For further studies in the utilization of earth-moving equipment, which can be used in determining the most suitable item of plant to be used in the operation conditions - see <u>Ibid</u> pp.118-159 and L M FORD "Notes in Construction Management" Civil Engineering Department, the University of Aston in Birmingham, 1973.

APPENDIX 10

THE COST UNIT BUDGET FOR THE OPERATION OF AN IMPROVEMENT PROJECT

In the previous two appendices, the method of programming the improvement work, and examples of the calculation which may be needed to choose the appropriate number of items of plant required for each operation have been described. It is assumed that these procedures have been completed, and this appendix is aimed at illustrating the schedules and forms required for preparing the operation budget of an improvement project. This will be demonstrated through the following example.

The operation is a part of project No. 3, and covered the following sub-base work.

The delivery of material to site by lorries from the source, tip it on site, spread it with a bulldozer, and then level it with a grader. Compaction should be carried out by a smooth wheeled roller and a small vibratory roller. The operation covered 10.000m², and the project programme of work shows the following:-

- 1. The operations duration is two weeks, starting 12.8.74.
- 2. The operation requires 1500t of 76mm down crushed concrete.
- 3. The gang should consist of 4 men; a working ganger and 3 roadmen.
- 4. It requires a bulldozer, grader, two 10-ton rollers and two 5-ton vibratory rollers.

 $^{^{}m l}$ All figures and estimates included in this example are hypothetical.

The information available to the control section is as follows:-

- 1. The cost of materials required delivered to site according to the accepted tender is £3.00 per ton (£2.40 per ton for materials and £0.60 per ton haulage).
- 2. Only the bulldozer and one of the 10-ton rollers are available from the central repair depot, and the rest of the plant should be hired with their operators.
- 3. The rate per/hr. for the county council workers is as follows:-

	Working Ganger	Roadman	Bulldozer Operator	Roller Operator
Wages Bonus Employment cost	1.60	1.06	1.51	1.40
	0.16	0.11	0.15	0.14
	0.20	0.13	0.19	0.18
Total rate p/h Cost for 40 h/wk	1.96	1.30	1.85	1.72
	78.40	52.00	74.00	68.80

- 4. The estimated rate for the county council plant calculated by the central repair depot central office is as follows: bulldozer £3.00/hr. and 10-ton roller £60/wk.
- 5. The hire rate for hired plant according to the accepted tender is:-A £58 per/day grader with operator.

(£44 per day for the plant and £14 per/day for the operator)

B - £124 per/wk. for the 10-ton roller.

(£60 per/wk. for plant, and £64 per/wk. for operator)

C - £79 per/wk. for the 5-ton vibratory roller.

(£15 per/wk. for the plant and £64 per/wk. for operator)

The operators are also entitled to a bonus payment equivalent to the rate of the county council worker. (It is 0.18p per/hr. for the grader operator at 70 pay performance).

To identify the activities covered by each operation according to the cost units codes, the table linking the programme of work, and the cost units codes described in Chapter 7 should be used; for this example the table will be as follows - assuming that the i-j of this operation in the network diagram is 2-5.

ROA	AD NO: A3	4	Party	PROJECT NO: 3					
	COST UNI		COMPANY OF THE STATE OF THE STA	Activities					
CODE	SCHEDULE	DESCRIPT- ION	i-j	Descript- ion	Duration	Start Time	Finish Time		
217	518	Sub-base & road base	2-5	Place & roll sub- base material	10 days	18.8.74	23.8.74		

According to this form, the budget schedules required for the cost unit 217 "sub-base and road base" in this project should be prepared, and in this case they are: the material schedule, table A.10.1, labour schedule, table A.10.2, and plant schedule, table A.10.3. The total of these schedules should then be carried forward to the project budget form, table A.10.4 with the rest of the project operational schedules.

The cost accounting records required for this operation

- 1. The material record should include only the cost element code no. 11232 76mm down crushed concrete, and 18132 Haulage for construction dry materials - hired lorries - as the materials will be delivered directly to site.
- 2. The labour records should consist of three separate records each should be used for recording the cost of each category or worker involved in the operation according to their sub-code classification.

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		WEEK	\rightarrow \(\text{\text{\$\sigma}} \)			
10 days 12.8.1974 23.8.1974		<u> </u>	H			
51,52		段の	Σ			
IOD:	BER	WEEK	G,			
PER DAY: DAY	WEEK NUMBER		Н	450	+50	
ESTIMATED PERIOD: STARTING DAY: FINISHING DAY:	WEEK	兴 2	×	1800 4	1800 450	
ESTI STAR FINI		WEEK	0	750 16		
		<u> </u>	н	450 7	+50	
		月 4	M	1800 1	1800 450	
		WEEK	3	750 11	-	
		<u> </u>	 3		0	5
		nΩT.	COST	4500	4500	71700
TIN	COST	LAGE		006	900	Š
IALS SCHED NO: 518		OF HAU	PRICE PER UNIT			THE TAXABLE SECTION OF
MATERIALS SCHEDULE NO: 518	ST.	KLALS	COST	3600	3600	
MA	TSOO	OF MATERIALS	PRICE PER UNIT	2.40		
		QUANTITIES		1500		E
			TINU	ц		
A34 3 CODE NO: 217 II"			DESCRIPTION OF MATERIALS	•76mm down crushed concrete	TOTAL COST	QUANTITIES COST OF MATERIALS COST OF HAULAGE
ROAD NO: PROJECT NO: OPERATION CODE NO: "COSTUNIT"			DESCRIPI	•76mm dow	H	Q = QUAN' M = COST H = COST
M O O D M		ITEM	CODE	11232		

															
ESTIMATED DURATION: 10 days STARTING DAY: 18.8.1974 FINISHING DAY: 23.8.1974		3K 3	COST												
		WEEK	NO OF HOURS												
	MBER	MBER	MBER	MBER	JMBER	MBER	2 3	COST	78.40	156.00	24.00	68.80	77.20	208.80	
ESTIMATED DUR STARTING DAY:	FINISHING DAY:	WEEK NUMBER	WEEK	NO OF HOURS	047	170	047	40	04	170		00+			
ESTIN	FINIS			COST	78.40	156.00	74.00	68.80	77.20	208.80		663.2			
			WEEK	NO OF HOURS	047	170	04	04	04	170		7+00			
			TOTAL	COST	156.80	312,00	148.00	137.60	154.40	417.60		1326.40			
				RATE	1.96	31.2 1.30	1.85	1.72	1.93	1.74					
			EMPLOYMENT COST	COST RATE	16.0	31.2	15.2 1.85	14.4 1.72	1	1		76.8			
EDULE	വ						EMPLOY	RATE	0.20	0.13	0.19	0.18	1	i	
LABOUR SCHEDULE	NO: 518	COST	COST WAGES BONUS	COST	12.8	76.4	12.0	11.2	14.41	33.6		110.4			
LABC				RATE	0.16	0,11	0.15	0.14	0.18	0.14					
				COST	128.00	254.40	120.80	112.00	140.00	384.00		1139.20			
		:	WA	RATE	1.6	1.06	1,51	1.40	1.75	1.60					
			NO OF MAN HOTTR		80	540	80	80	80	240		800			
4,	+		/DE CEBS	MORI MOBI	_	. †	2	М	2	2					
ROAD NO: PROJECT NO: 5 COMMUT CODE NO: 217		DESCRIPTION			WORKING GANGER	ROAD MEN	BULLDOZER OPERATOR	ROLLER OPERATOR	GRADER OPERATOR	ROLLER OPERATOR					
TA PA	ч <u>с</u>		SUB)	21	21	23	23	25	25					
					,						······································	1			

TABLE A.10.2 LABOUR SCHEDULE

			턵							
10 days 12.8.1974 23.8.1974		WEEK -	COST							
10 d 12.8 23.8			COST of							
1		WEEK -	900							
RATIC : Y:		ΞM	COST of							
ESTIMATED DURATION: STARTING DAY: FINISHING DAY:	ER	WEEK -								
IMATE RTING ISHIN	WEEK NUMBER	WE	No. COST of						·	
EST. STAI	WEEK	WEEK	COS							
		W.E	No. COST of							
		□ .	COSI	120	50	09 .	30	220		480
		WEEK	NO H	047	94	04)	8	40	**************************************	480 240
		WEEK 1	COST	120	50	09	30	220		1 1
	*	WEE	No. of H	07	0+7	707	80	047	.,	240
			TOTAL	540	100	120	09	055		096
EDULE 18		COST	HIRED PLANT			120	9	044		620
PLANT SCHEDULE NO: 518	NO.	:	C.C PLANT	540	100	.			·	340
PI		HOUR	HIRED PLANT			1.50	0.375	5.50		
		EALE FOI	C.C PLANT	3.00	1.25		, , , , , , , , , , , , , , , , , , ,			
		NO. OF WORKI PLANT/HOUR		80	8	80	160	80		480
	NO.	OF	PLANT IRED	←	<u>τ</u>	ζ-	~	~		
ROAD NO: A34 PROJECT NO: 3 CCSTUNIT CODE NO: 217		DESCRIPTION		BULLXZER (TRACTOR)	ROLLER 10-TON (DIESEL)	ROLLER 10-TON (DIESEL)	VIBRATORY ROLLER (HAND)	GRADER		TOTAL
RO, PRC	THE A TOT	CODE	2	32114	32512	32522	32525	32913		

TABLE A.10.3 PLANT SCHEDULE

1	<u></u>	3	l	
	REMARKS			ander de la companya de la companya de la companya de la companya de la companya de la companya de la companya
	CONTRACT WORK SCHEDULE			_
	PLANT SCHEDULE	00.096		ģ.
	LABOUR SCHEDULE	1326.40		
NO: A34	MATERIALS SCHEDULE	4500.00	A market and the state of the s	
	TOTAL	5536.8		
	DESCRIPTION OF OPERATION		TOTAL COSTS	
ROAD CODE NO:	SCHEDULE	518		~
	OPERATION CODE No	217		

TABLE A.10.4 THE OPERATION BUDGET

2 cont'd

It is, for this example, sub-code 21 permanent road men; 23, permanent drivers and plant operators; and, 25, drivers and plant operators for hired plant - (the difference between these records is only the use of the appropriate code).

3. Plant records should cover: cost element 32114, county council tractors; 32512, county council diesel roller; 32525, hired diesel roller; 32525, hired vibratory rollers, and 32913, hired grader; in the same manner as described in Chapter 4.

The purchase section

The purchase section should order the delivery of 1500t of the required materials one week before the start of the operation, leaving the daily delivered quantities to be determined off by divisional supervisor.

The variance reports

The weekly variance reports of the first week's performance, which should be presented to the construction supervisor and to the divisional construction engineer, should be presented to them on Monday morning. The divisional engineer should receive an action report from the construction supervisor early p.m. on Monday.

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