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**INTEGRATED SYSTEMS FOR SITE
MANAGEMENT**

BY

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**A DOCTORAL THESIS
SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF
DOCTOR OF PHILOSOPHY
OF THE LOUGHBOROUGH UNIVERSITY OF
TECHNOLOGY**

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c R. Z. ABDULLAH

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

”وَقُلْ رَبِّیْ زِدْنِیْ عِلْمًا”

(صدق الله العظيم)

IN THE NAME OF GOD, THE MERCIFUL AND THE
BENEFICIAL

”AND SAY, MY LORD; INCREASE ME IN KNOWLEDGE”

(THE HOLY QURAN)

DEDICATION

"TO MY PARENTS AND ALL FAMILY WHO HAVE GIVEN ME LOVE,
TRUST AND ENCOURAGEMENT THROUGHOUT MY LIFE"

" The control of costs is the life-line of any competitive business; no business can survive without a knowledge of costs and intelligent control of costs ".

**"Construction Cost Control"
American Society of Civil Engineers**

SYNOPSIS

The operation of an efficient and integrated site management system is one of the problems that still requires a considerable amount of attention in most of the construction companies in U.K. This thesis describes the research I have undertaken on this problem and how a computer-aided construction management system can assist in solving the problem.

The thesis has been divided into three sections according to the research. The first section describes the research I have undertaken as surveys on;

- the literature as an existing knowledge of efficient and integrated site management systems;
- what systems are applied on site and the degree of satisfaction from them;
- the facilities that can be provided by the available site management software;

From the above surveys, the problem has been identified and the objectives established for the research.

The second section of the thesis describes my development of a software model to facilitate collecting, processing and analyzing data from the site for producing control data and reports. The

section also describes the integration of the model to the other construction management systems (i.e. estimating, planning, cashflow forecasting and valuation), as well as being self-contained.

The last section of the thesis describes my research in investigating how well the model achieved the research objectives. This section described a number of case studies based as a demonstration of the model, its functions and mechanism, using slides and on-computer seminars. From this evaluation I have established a list of comments, some of them were used to modify the model or as conclusions and recommendations for any future research in this field.

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CHAPTER ONE

CHAPTER ONE

INTRODUCTION

GENERAL

Site control is a process whereby the management ensures that the organization as a whole achieves desired standards of costs and values established at the estimating and planning stages, by using actions directed towards achieving these standards.

Construction companies site control functions encompass the functions of accounting, cost monitoring, control of actual cost as well as the resource performances against the budget, and forecasting the project cost for the next period of time.

Construction company site management still suffers from difficulties, such as the large number of the staff required for collecting the data and undertaking calculations, the long time spent for producing the control reports which is often 15 to 30 days, as well as a deficiency in the reports actually assisting efficient control of the construction operations. Computer-aided construction management has long held the unfulfilled promise of reducing these difficulties by producing an integrated and efficient site control system which could make better use of the data to achieve better management on site.

Surveys of literature on existing computer systems and their

application in the construction companies indicate an absence of an effective integrated site control system for efficient site management, some possible solutions to the problems and the difficulties involved. This thesis addresses all three of these issues.

This chapter gives the outline of the research as follows:

- * a description of the historical background to the problem;
- * the research surveys, and the findings which come from these surveys as the research objectives and testable hypothesis;
- * a summary of the work undertaken and its achievements;
- * a guide to the thesis.

1.1) HISTORICAL BACKGROUND ON THE ATTEMPTS FOR COMPUTER-AIDED INTEGRATED MANAGEMENT SYSTEMS

Despite the fact, that computing power is becoming relatively less expensive all the time, computers still appear to be grossly under-utilized in the construction industry. According to recent figures (ref. 63), there are about 88,000 construction establishments in Europe of which only 17% use computers to some degree with no indication of any attempts in computer-aided construction site management and control.

Two surveys carried out in 1979 by Bensasson (64) and Hamlyn-Harrison (86), have shown that most of the computer programs available cover only:

- estimating
- network analysis
- cashflow forecasting

More recently in 1984, Wager (49) has expanded these surveys to include:

- valuation
- accounting

The accounting packages identified are largely designed for financial accounting (at a company level), and are used for contract costing only.

There have been several attempts at site control with little success, as these attempts basically remained as accounting systems.

By and large, these systems stand by themselves. In computer jargon, they are known as stand-alone. This is as surprising as it is undesirable considering the inter-related nature of these processes in construction. For instance, the construction programme of a project has an influence on the estimate of costs as well as cashflow while the basis of any effective cost control must be the figures which are prepared by the estimator before submitting the tender (ref. 71). It therefore, seems possible for these systems to use common data bases.

There were a few attempts at the total system approach in the United Kingdom to provide an integrated site control system, none

of them reached the level of integration required to solve the difficulties and problems of efficient site control. One of these attempts was provided by Project Cost Model, (PCM system) developed by Project Software Ltd. (ref. 53), which is considered to be a good planning system having an efficient control on resource performance on site, but it has no ability to control the costs and the values on site because it does not have the facilities to deal with Bill of Quantities (BoQ). As a cost control system, it hasn't fully achieved the required integration to the other management systems of Estimating, Valuation, Bonusing and Material Control (despite being integrated to the Planning system), because it wasn't developed to be integrated to these systems. There is no access for the management data between PCM and these management systems, hence PCM has not achieved integrated site management system requirements

In the latest attempts at integration, a system in the INTEREST-CE package (ref. 81) was developed by Loughborough University of Technology, and sub-systems for cashflow forecasting "PLUS CASH" (ref.79) and time analysis and resources balancing "TIANAREBA" (ref, 80), and valuation and measurements and price adjustment "PLUS VAL" (ref. 62) are being linked to INTEREST. This attempt did not reach the required level of integration as it did not allow the data passes from these systems to be used in site management systems such as monitoring and control of the site by comparing the actual cost and resources performances on site against the budget, also these systems do not accept the data from the comparison as feedback data to the estimator to update his estimates.

Despite the all above mentioned attempts at producing an integrated construction management system, there are still number of gaps (constraints) in the management information systems. These gaps have stopped the free flow of the management data down to the construction site, to enable feedback from the site with its control results to the other managerial data bases.

1.2) THE RESEARCH HYPOTHESIS

From the back ground described, it can be clearly seen, that there are still number of technical constraints impeding the computing of construction management data. The constraints lie in the management systems and data structures. Thus if it can be demonstrated that these constraints can be solved, then the free flow of information is possible with the resulting benefit to management at all levels in the construction industry.

1.3) THE EXISTENCE OF ON-SITE COST AND CONTROL SYSTEMS

Surveys were undertaken of literature, construction firms and software houses to identify the constraints mentioned in the hypothesis. The three points investigated were:

- what existing literature recommends as good practice in site control systems;

- what systems are currently being used by construction companies with their requirements to improve these systems;
- what facilities the available software packages can offer.

1.3.1) The Literature Survey

The literature was reviewed to determine the existing knowledge of efficient site control systems, so that a contractor's questionnaire could be developed.

1.3.2) Construction Company's Survey

A list of questions about what systems applied on site and the degree of satisfaction from using these systems was compiled and thirteen construction companies were interviewed. Their recommendations and requirements for improving their systems were also included in the discussion. The survey had identified two sets of objectives, firstly the facilities available in the systems, secondly, the requirements of these companies in an efficient and integrated system.

1.3.3) Computer Software Survey

A survey was conducted as a questionnaire by eight computing companies which had developed site control software. The questionnaire enquired about the facilities that the software provided. From the construction companies survey and this survey, the missing gaps between the facilities requested and those available were established

1.4) THE RESEARCH OBJECTIVES

Against the above survey findings, the objectives for the research were established which were divided into main and secondary objectives

1.4.1) Main Objectives

The main objectives of the research were to:

- _ examine the adequacy of existing site control software when compared to the requirements of construction companies and to produce "Business Requirements" specification for an efficient and integrated site management;
- _ examine the feasibility of an integrated site control system linked to the other construction management systems of; Estimating, Planning and Valuation and to produce the Data Requirements for such integration;
- _ develop a software model to fulfill the specification and the requirements and assist in achieving integrated computer-aided site managements system;
- _ develop a software model which passes resulting data back to the Main Office from the site as feedback to the Estimator and Planner;

1.4.2) Secondary Objectives

In addition to the above main objectives, the following were found desirable (as facilities in the developed software) to fulfill the promise of having an integrated and efficient site control which could make better use of the data to achieve better management on site. These objectives were to:

_ achieve the following management functions on site from the site sheet data:

- a) weekly costing of labour and plant;
- b) control plant and labour performances;
- c) control material cost, wastage and utilization on site;
- d) control and account the subcontractors' work and payments on site;
- e) control the preliminary cost and usage on site;
- f) adjusting the actual cost/value according to the variation orders, claims, daywork, on-cost labour overheads and price fluctuation.

_ provide the following control data on site for the monitoring, controlling and cost forecasting purposes:

- a) cost/value reconciliation;
- b) cost/value variances;
- c) budget costing;
- d) short term planning and control;
- e) material usage;
- f) preliminary overall project usage;
- g) feedback to the upper levels on site and to the Main Office Departments.

1.5) THE RESEARCH JUSTIFICATION

The justification for these objectives were:

- there is an increasing need by the construction

companies for more effective integrated site control systems. There is a lack of software to meet this established need;

- computer technology has improved a great deal in recent years by developing integrated estimating and planning and valuation systems and the construction industry should take advantage of this by using the same technology for developing an integrated site management system;
- the falling hardware prices should make the proposed use of computer-aided site control valid.

1.6) RESEARCH METHODOLOGY

To overcome the existing constraints (which have stopped the current integration in the management information systems), and show how the gaps between the management systems can be bridged, I have developed a computer-based integrated site management system (PLUS COST). PLUS COST is capable of being implemented as a stand-alone systems or linked to other management systems of Estimating, Planning, Cash Flow Forecasting and Valuation and Measurement, for achieving efficient site management.

The model (PLUS COST) has been developed as part of the research according to the following steps:

- 1 - identifying the required outputs as site control data required on site according to literature and the construction companies requirements;
- 2 - identifying the input required for achieving the required

- output and to provide efficient site management;
- 3 - identifying the possible contribution of the other management systems in providing the required input data for the model;
 - 4 - examine the availability of such management systems which could provide such contributions;
 - 5 - examine the other reasons which may stop the data integration between the management information systems.

PLUS COST has been developed as part of the research to meet these requirements as the continuation of the production of series to a series of integrated software systems (in Estimating, Planning, Cashflow Forecasting and Valuation and Measurement), developed at Loughborough University, the software have been examined, to ensure that the required data can be extracted from their data files (as explain in chapter five).

PLUS COST then used to demonstrate the integration constraints as well as the efficient site management problems and the achievement of the research in removing the constraints and solving the problems.

The research achievements then evaluated, by using the model, from the construction management personnel point of view. Their comments were collected for modifying the research findings and as recommendations for future work in this field.

1.7) THE WORK UNDERTAKEN

The work on the research has been divided into three sections as shown in figure (1.1).

In the first section, the research has been undertaken as surveys on:

- _ the literature to determine the existing knowledge of efficient site control systems, from which the questionnaire for construction companies has been developed.
- _ the systems applied on site and the degree of satisfaction from these systems by interviewing thirteen construction companies, using a questionnaire developed from the last survey. The survey had come out with two sets of objectives, firstly the facilities available in the systems used, and secondly, the companies requirements for an efficient and integrated site control system;
- _ the facilities that can be provided by the available software in the market by interviewing eight computing companies (which had developed site control software). From the above surveys and this survey, the missing gaps between the facilities requested and those available has been established as the objectives of the testable hypothesis of the research.

The second section of the research work was devoted to examining the feasibility of an integrated site control system linked to the available management systems such as; Estimating,

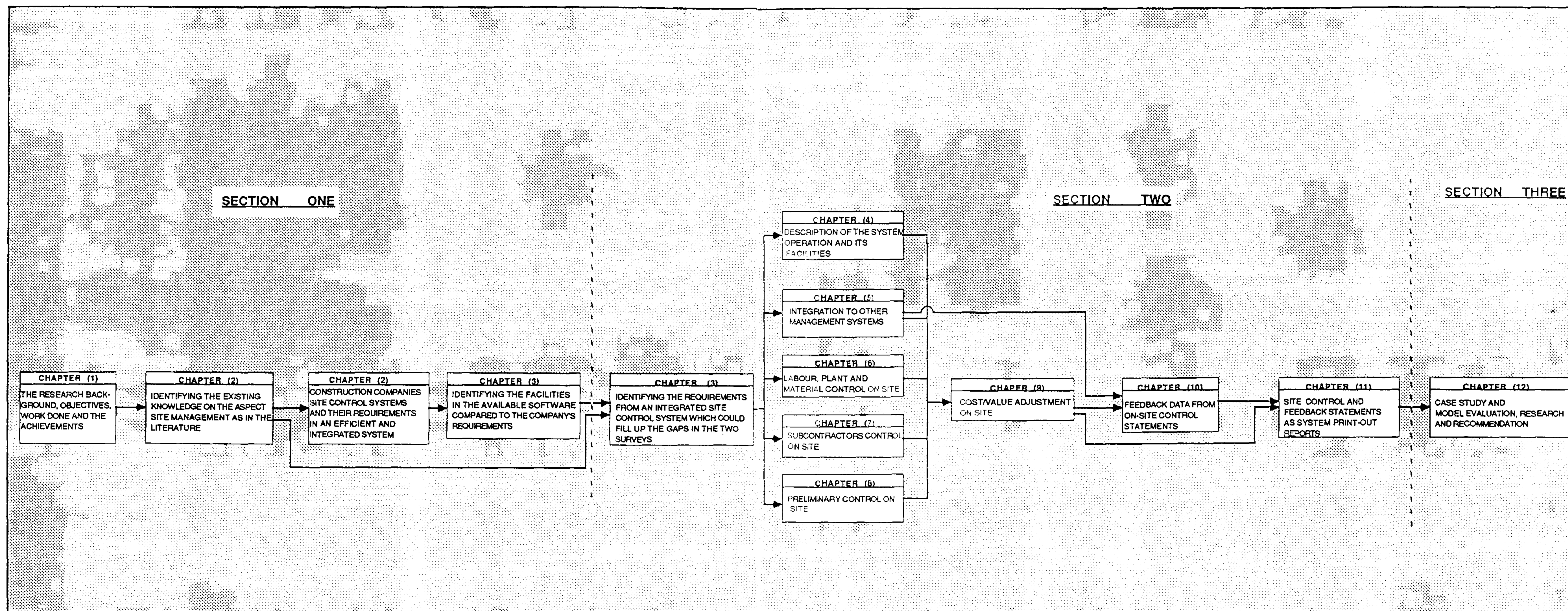


FIGURE (1.1); THE THESIS CHAPTERS' DIAGRAM WITH THEIR INVOLVMENTS IN THE RESEARCH PROBLEM SOLVING

Planning, Cash flow Forecasting and Valuation and to produce the Data Requirements for the integration. This specification and the requirements of the construction companies from the first section were both considered in developing a software model to facilitate collecting, processing, and analyzing data from site for producing control data and reports. This model has been developed to be integrated with Estimating, Planning and Valuation systems as well as being a self-contained model. The model program is called "PLUS COST".

The last section of the work covered an investigation into how well the model has achieved these objectives. A number of case studies have been undertaken as a demonstration of the model, its functions and the mechanism (as in slides and on-computer seminars) to a number of industrialists who were selected from different construction companies. From these cases, a list of comments has been assembled, and some of these comments were used to modify the model or as conclusions and recommendations for any future research in this field.

1.8) THE RESEARCH ACHIEVEMENTS

Through each section of the work done in the research, part of the objectives and aims were achieved, so that the achievements of the research have been divided into three sections similar to those in the work undertaken.

Through the first section, the first objective has been achieved. In which the research has:

- identified the current requests of the construction companies from the site control systems, even those companies which had developed their own control systems but were not satisfied with them.
- established the gaps to reach the required fulfillment of computer-aided site control and management.

From the work undertaken in the second section of the research, the last three main objectives as well as the secondary objectives have been achieved. In this section, the research has:

- established the "Data Requirements" of an integrated site management system linked to the other management systems by examining the feasibility of such linking;
- developing a model which can achieve the following functions;
- * the required integration, in construction management, between the site and the main office by sharing the data files with estimating, planning and valuation systems and then passing back the site control data from the model to these systems. This will save unnecessary duplication in entering the data and therefore on the number of staff required. In addition integration will make the use of the data through different construction management systems more efficient;
- * an efficient site control system which has the ability to produce control reports and as many as eighteen output reports as well as on-screen reports that cover all the site control user's requirements;
- * providing the following facilities as part of an efficient

and integrated site management system:

- control of on-site cost and usage of project resources;
 - control of preliminaries on-site;
 - adjust the on-site cost/value from claims, variation orders, daywork, on-site overheads and price fluctuation;
 - determine the actual cost of the work done;
 - determine the final account of the project.
- * providing an efficient filing system which is able to store all the data about contract data, claims registration, variation orders, daywork, feedback comments and BoQ to be recalled whenever required.
- * solving one of the problems of using computers on site which was the complexity in the systems available. This problem has been solved by designing the system to be very simple in capturing the data by typing in the data according to questions similar to those in the site sheets. Also the control reports that the system can provide have been designed to be simply presented, well detailed and easily understood by the user.

The last achievement was reached through the third section of the research, when a set of recommendations were developed from a number of case studies, to be considered in any future work.

1.9) A GUIDE TO THE THESIS

Figure (1.1) gives a diagrammatic guide to the thesis as follows:

Chapter 2 describes the literature review of existing knowledge on efficient site control systems and describes the systems. It also contains a survey of the systems currently used by the construction companies.

Chapter 3 describes the other surveys, one on the companies requirements of a site control system and the other on the facilities that can be provided from available software.

Chapter 4 contains a description of PLUS COST from the operational view with its general features and the functions that can be carried out by it.

Chapter 5 explains the integration facility in the system and how the system is designed to be a stand-alone system as well as integrated to the other construction management systems.

Chapters 6-8 Based on the findings contained in chapter 2 and 3, to describe the costing functions in the model, the flow of data from the site and the necessity of these functions in the model for site management.

Chapter 9 describes the cost and value adjustments on site which come from the site practices of; on-cost labour overheads, claims, variation orders, daywork and price fluctuation.

Chapter 10 explains the aspect of feedback in the model as one of the important findings of the surveys in chapter 3.

Chapter 11 contains a description of the off/on site control and monitoring reports that "PLUS COST" can provide with the necessity of these reports to the construction organization on and off site.

Chapter 12, this final chapter contains descriptions of some case studies on "PLUS COST" and the model evaluation from these studies. It includes also the research conclusion and recommendation for any future study in this field.

CHAPTER TWO

CHAPTER TWO

SITE CONTROL OF THE CONSTRUCTION PROJECTS

2.1) INTRODUCTION

Since control is a process whereby management ensures that the organization is achieving desired ends. It can be defined as: "a set of organized (adaptive) actions directed towards achieving goals in the face of constraints" [Wilson (1)].

The existence of a control process enables management to know from time to time where the organization stands in relation to a predetermined future position. This requires that progress can be observed, measured and re-directed if there are discrepancies between the actual and the desired positions (ref. 1).

This chapter explains the first part of the research survey that was undertaken to identify what is contained in the literature as existing knowledge on the site control system, compared with what is used by the construction companies, so that this chapter has been divided into two parts. The first part reviews the literature on aspects of site control. In this review, the chapter explains the site control; definition, terminologies, purposes, benefits, management stages and the different techniques which can be used to control the site. It also explains the policies required to increase the effectiveness of controlling the

construction site, in addition to this, a set of designing points and efficiency requirements in the site control are listed at the end. From the literature survey on this part, the existing knowledge on an integrated and efficient control of the construction site has been obtained. The second part explains how a questionnaire has been developed from the previous review to be used for examining the efficiency and the integration in the construction company site control systems by interviewing a number of construction companies.

From these two parts, the efficiency gaps in the site control systems used have been identified; also the requirements of the construction industry in any efficient and integrated site control system were established. These requirements were then used for examining the efficiency and the integration of the available site control software in the market, as explained in chapter three.

2.2) LITERATURE REVIEW ON SITE CONTROL SYSTEMS

The first part of this chapter (as mentioned) reviews the existing knowledge of the site control as contained in literature, so that a full understanding of the aspect of the site control can be achieved before going further in the research and examining and achieving the objectives which have been established through the research.

2.2.1) Definition of Contractor's Site Control Systems

Contractor's site control systems can be

defined as the complete process of controlling and monitoring expenditure of a project by the contractors from the time of tendering, through the construction phases, to the end of the maintenance period and until the last retention payment has been released by the client, [Gobourne (2)].

So that, the main elements of any site control system are:

- to observe the records of the actual cost and performance of particular aspects of the project at regular intervals;
- to compare the observed cost and performance with that estimated or planned;

The end results of these comparisons are that management uses the information that:

- a) if any operation is proving uneconomical compared with the estimate, then management can take corrective action if necessary.
- b) by comparing actual site data about use of resources against that planned, the expected use of resources can be forecast and corrective action be taken to maintain the project plan.
- c) the data gathered from such an exercise provides the necessary feedback to the original estimate, so that future estimates of a similar nature can be prepared accordingly.

2.2.2) Some On-Site Cost Terminologies:

Three aspects outlined in this matter which need to be distinguished are; "COST ACCOUNTING", "COST MONITORING" and "COST CONTROL" (ref. 3).

- **Cost Accounting** is generally concerned with accumulating the actual costs of construction, both direct and indirect, and allocating the direct cost to the operation that incurred them, together with a proportion of the indirect cost.
- **Cost Monitoring** is concerned with comparing the actual data with the budgeted cost to produce a budget/actual cost variances. This process is of course, essential but quite inadequate by itself as a control system for management. Historical cost information is not of much use when the operation has been completed and shown to have made a loss. Past costs can not be controlled.
- **Cost Control** is used to maintain the costs within the budget by forecasting the expected costs through frequent short term planning exercises in order that corrective action can be taken whenever necessary to keep the costs within the planned budget.

Therefore any site control system could have one or more of these three aspects and the efficiency of the system then depends on the involvement of these aspects in the system.

2.2.3) Purpose of Site Control

Site control for a project needs to be carried out for the following purposes (ref. 3):

- _ to provide information that enables periodic statements of profit and loss to be drawn up for each project at regular intervals of time, probably at monthly intervals for small projects but almost certainly weekly intervals for large or fast-moving projects. In turn, the project statements will be broken down for individual operations or sections of the work. The project statement of cost will itself facilitate the production of a composite statement showing the overall company position on all its projects;
- _ to highlight particular activities or operations within a project which are being pursued in an economic fashion, for example, excessive wastage of materials, inefficient utilization of mechanical equipment, labourers or resources as a whole;
- _ to provide cost data on which management can act within a satisfactory time-scale. In the case of activities which are currently being pursued uneconomically, costing information must be variable at least within the duration of the activity. This enables a decision to be taken with the real prospect of an improvement being effected before the activity duration expires;
- _ to enable the staff who have estimated the cost of the work to gather feedback information (properly and adequately described) in order to check the efficiency

of their original assumptions in preparing the estimate of cost. Also to provide this information in such a way that it will facilitate the preparation of future estimates;

- _ to facilitate the preparation of a budget for the future operation of a company particularly in respect of the contribution to be made to the company's overheads and its general administration costs;
- _ to provide operational information on equipment and plant in order to assist in the economic selection of equipment for future work and the selection of plant for purchase;
- _ to provide the necessary information in order to guide a company into the areas of work for which it is best equipped to carry out what it finds most profitable. Hence it forms one part of the basis for a long term corporate plan.

2.2.4) The Benefit of Site Control

The benefit from any site control system can be summarized as:

- _ savings achieved by all persons on the project being cost-conscious;
- _ cost reductions made by focusing attention on trouble spots while there is still time to take corrective action;
- _ deletion of changes that cannot be economically justified;
- _ early notification of cost over-runs that cannot be

corrected (i.e. elimination of cost blackout periods).

2.2.5) Management Control Cycles Applied in The Construction Projects

Any cost control and cost monitoring system should contain the following stages to which a manager of a construction company passes each time he is engaged in problem-solving (ref.5).

FIRST STAGE is to fix the standards or objectives which need to be achieved (i.e: estimated costs at the estimating stage).

SECOND STAGE: having fixed the standards, these will then be used for the preparation of a plan of the project in order to set out the sequences and inter-relationships between all the activities which go to make up the plan as well as scheduling the work in packages.

THIRD STAGE is to measure and record accurately the progress being made on the project by using a significant reporting system which is set up in order that various levels of management concerned can be kept informed of progress being made towards the objectives as well as forecasting the future.

Having finished these three stages, the decisions can be made, the previous stages will be repeated, taking into account the deviation between planned and actual costs, until the desired results are reached, as shown in figure (2.1).

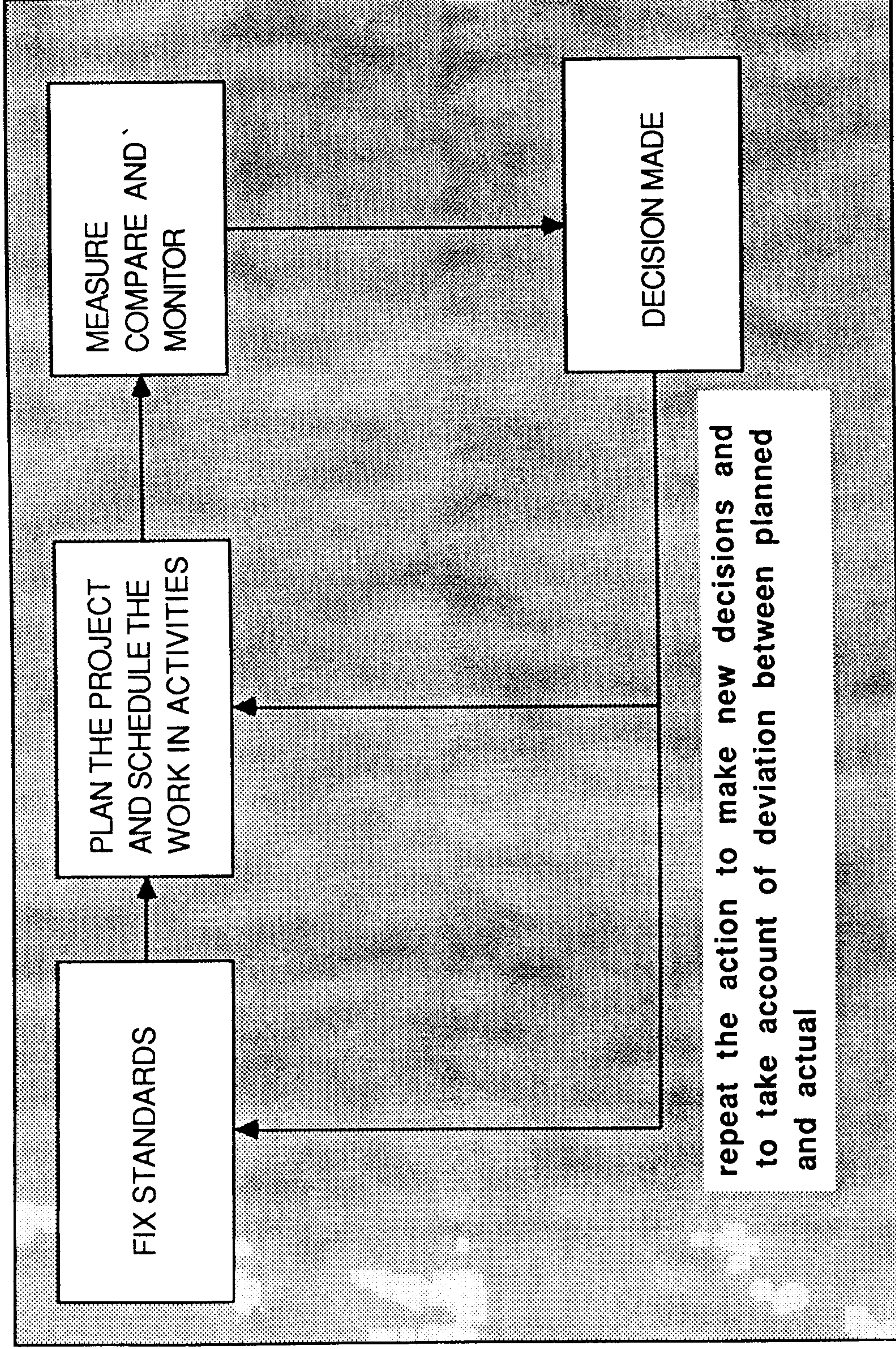


FIGURE (2.1) : THE MANAGEMENT CONTROL CYCLE

As a consequence of the above, we have to bear in mind that in designing and using a cost control and monitoring system, such a system should (ref.5):

- _ provide the relevant feedback, carefully qualified in detail, for all the conditions under which the work has been carried out, [e.g. CESMM-Civil Engineering Standard Method of Measurement (ref.20), SMM6/7 Standard Method of Measurement for building works (ref.18)], to the estimator, who has responsibility for updating the standard for future use;
- _ provide data to assist in the valuation of those variations that may arise during the course of the work;
- _ promote cost consciousness;
- _ summarize progress.

Therefore, and according to the modern project management, the control of the cost can be defined as "the correct application of the technical science in the industry to produce the least costly production within given guidelines" (ref. 84). To achieve such a definition, a link between the management (planning and control) and the accounting is required, so that the accounted actual cost will be compared against the planned cost, and from that the project planned cost and performance will be utilized and revised if required, as in figure (2.2). The figure shows the relationship between management (planning and control) and the accounting system, furthermore the figure indicates the cost monitoring and control cycles which require both management and accounting.

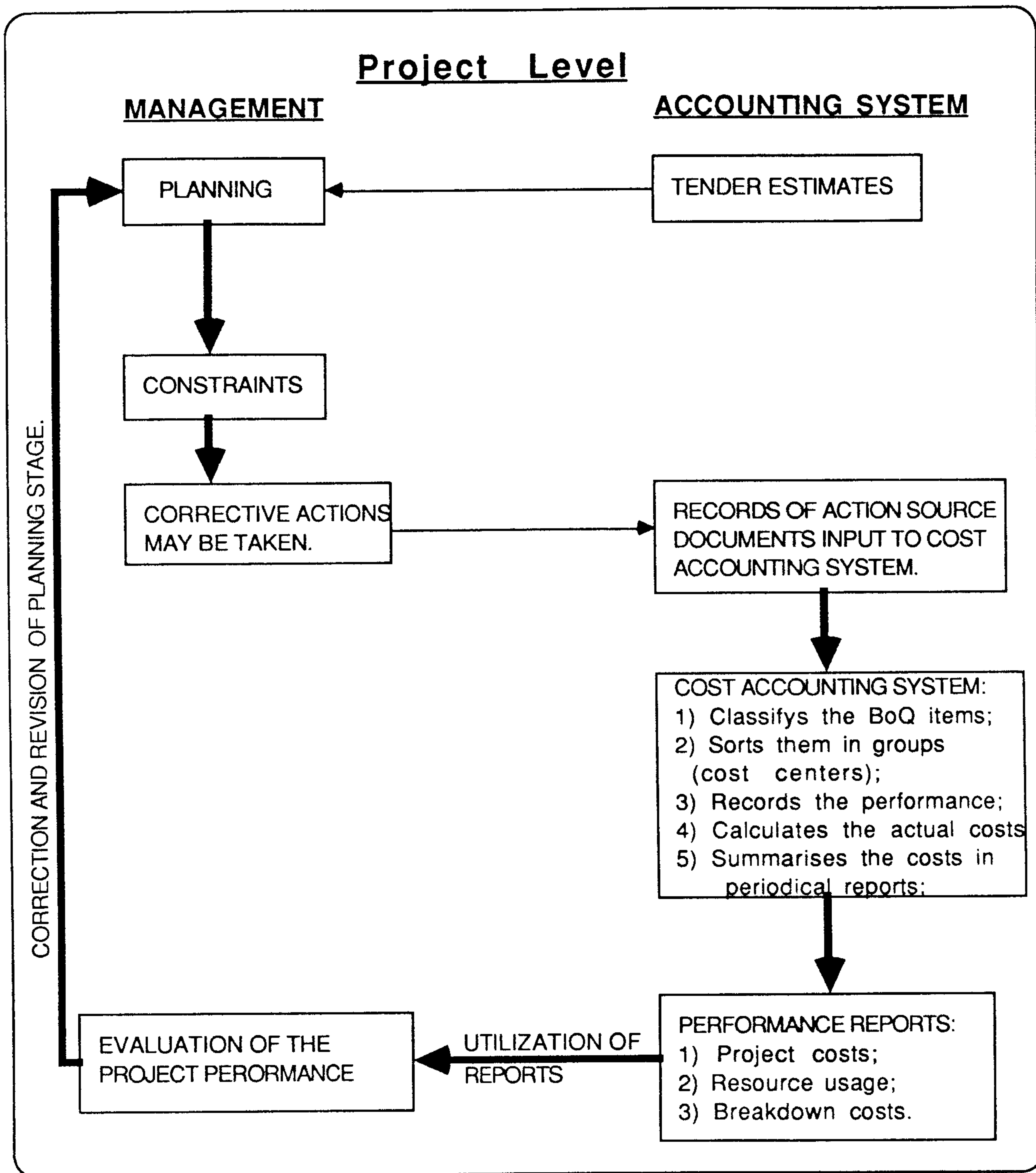


FIGURE 2.2: SHOWS THE RELATIONSHIP BETWEEN MANAGEMENT PLANNING AND CONTROL THE PROJECT COST ACCOUNTING SYSTEM.

2.2.6) Contractors' Site Control and Management Techniques

The following techniques are amongst those at present used by civil engineering and building contractors to control and manage construction costs on site, with their advantages and disadvantages, (refs. 2,3 and 6):

i) *Budgetary Control*

It is also called overall profit or loss. In this system, the contractor waits until the contract is complete then compares the sum of money that has been paid with the money incurred in purchasing materials, payments for labour, plant subcontractors and profit/overheads.

Advantages:

- there is not too much calculation in it;
- it is a very simple and cheap system;
- it is suitable for very small contracts of short duration, involving few men and little construction equipment;
- does not need many staff to work on it.

Disadvantages:

- the information it produces can only be used to avoid the recurrence of gross errors in contracts;
- it is a very simple control system which can not be used for a big project, of a long

duration;

- we can not control the project's cost while it is in progress because all the reports which will be taken from the system are considered as historical data which might be useful only for achieving future projects.

ii) Profit or Loss on Each Contract at Valuation Dates

The total costs to date are compared with valuation gross of retention. In this system all the material not invoiced but delivered must be included and also all the material not yet built into the permanent work must be excluded. Sometimes this system is called monthly profit or loss because generally the interim payments used to be on a monthly basis.

Advantages:

- it can be organized with interim payments to the contractor which will be considered as the value of the work done within the last month;
- this system can be used to give guidance on the contracts which require management attention;
- there are few calculations required.

Disadvantages:

- there are no breakdown figures of the profit or loss between types of work;

- one month is too long to indicate exactly the problem area;
- any corrective action needing to be taken would be too late to rectify the problem;
- it is not suitable for contracts which involve significant set up costs which are distributed over unit costs.

iii) *Weekly Basis Profit or Loss*

In this system, the contractor compares on a weekly basis the total cost (in terms of labour, plant, material, subcontractor and overhead) with the total value of the work done.

Advantages:

- one week is reasonably long enough to indicate the exact problems and then decide the corrective action required;
- it is easy to calculate and feedback the data, as the allocation sheets and/or the time plant and labour are on weekly basis;
- it is a very simple accounting system to use.

Disadvantages:

- it needs continued calculating procedures week by week that increases the administration cost;
- sometimes you can not get accurate data especially about the material, if there is

material being delivered to the site.

iv) *Operational Cost System*

This system is only appropriate for jobbing and specialist firms. It consists of job cards containing a complete job description on the back, time spent and goods received.

On completion of the job, the card contains an account of plan and achievement. This system is generally on a weekly basis.

Advantages:

- it is a very simple system which does not have any calculations;
- it is suitable for special small building firms;

Disadvantages:

- if the work embraced is too extensive or complex, the system fails;
- it does not give any indication of the allocation of profits or losses in the site operations;
- it is not quite a detailed system.

v) *Spot Cost System*

It is a cost check carried out on site on an individual element or section of a contract; this system may be

applied for one of the following three reasons:

- a) as a check on a regular site cost control system;
- b) as a detailed study of a particular operation where the cost control system does not give the required information in the correct form of detail;
- c) as a recorded cost of a particular operation agreed with the client and used in later negotiations as the basis for the revision of payments;

Advantages:

- it is a very simple and quick costing system;
- it is efficient in assisting the main costing system in indicating the efficiency of the system;
- it does not need too many calculations;
- it is a well detailed system for an individual element or section of the contract.

Disadvantages:

- it is a very limited costing system which can not be used as costing system for a whole project or contract;
- it is a very simple system without having enough details about the breakdown figures of profits or losses for each type of work.

vi) Unit Costing System

The contractor calculates generally on a weekly basis, the unit cost (£/m) in terms of labour and plant for each given operation and then compares that with the estimated labour and plant unit cost for the build-up of the total of each item shown in Bill of Quantity (BoQ).

Advantages:

- it is easy and simple in carrying out the required calculations;
- one week is reasonably long enough to produce quick corrective action when necessary;
- it is a good means of data feedback to the company's estimator.

Disadvantages:

- it does not control material usage which could be reconciled by using a separate system;
- it is not a very efficient system in controlling the contract financially as the comparison is based on labour and plant only;
- it is not detailed enough to indicate accurately the problem area.

vii) Standard Costing System

The contractor calculates generally on a weekly basis, the total cost of carrying out each given operation. This cost is then compared with the total estimates used for the build-up of the total for each item rate shown in BoQ.

Advantages:

- it is more detailed than the previous systems;
- it is the most popular method used in the construction industry;
- it is efficient and quick to operate;
- it provides a better overall view of how well a contract is doing in comparison to the unit costing system.

Disadvantages:

- because the comparison can not be carried out until the completion of the operations, it will be too late for the management to take any corrective action that may be needed to rectify the problem area, after the operation has been finished;
- the system is seldom directly applicable to construction owing to the variety of the product.

viii) PERT/Cost (Project Evaluation Review Techniques)

Sometimes, it is called network control. This system requires from each contract to be networked, the value of work assessed in advance. The estimate is compared then with reality.

For each review of the project's progress, it is necessary to allocate actual cost, liability incurred and estimated costs of the uncompleted work.

Advantages:

- in the right circumstances, it would be a powerful tool;
- a report can be obtained which indicates whether the project is ahead or behind schedules, and if the work has been performed efficiently;
- reports can be obtained related to the estimated position at the end of the project and the change since the previous review.

Disadvantages:

- the system can not be applied directly where the work is valued by a bill of quantities, which related to a completed work rather than the operation;
- it is a very sophisticated technique and requires substantial computer power which

limits its use;

- there is a problem of ensuring that all cost incurring activities are included in the network and any review should be mirrored to the project cost where necessary. So it is essential to use the computer for its calculations, by which we can make a comparison of the list of the activities of the current and previous runs;

ix) Short Term Planning and Control System (S.T.P.C.)

This might be called Pre-Based Cost system. In this method, the Section Engineers prepare short term plans showing proposed activities and resources requirements. The planned cost is determined in advance together with the value of the proposed work.

The plan is accepted if it shows a satisfactory favorable variance, otherwise, it is improved to a point at which no more improvement can be added, and as the work takes place, the manager monitors the work, if it is not proceeding to the plan, he will take corrective action while the work is still in progress (ref. 43)

Advantages:

- you can take corrective action while the work is in progress;
- it is easy to be computerized by which the effort required from Section Engineers will

be reduced when the computer will carry out all the calculations on the input supplied by Section Engineers.

Disadvantages:

- without using a computer, there will be a lot of calculations required to be done by Section Engineers;
- it does not take usage of material and overhead costs into account;
- the accuracy of the system depends on the Section Engineers themselves, who should have enough experience in setting up the plans for their sections and also in forecasting costs and values;
- it does not take claims and variations into consideration;
- it doesn't indicate overall project financial progress.

2.2.7) Cost Coding System

The success of a cost control system will depend on the extent of the ability to develop a sound system of identifying a coding technique for basic cost data. The reasons for requiring an adequate coding system are:

- a) it simplifies the data-handling facility;
- b) it provides a systematic filing system;
- c) it provides a wide range of characteristics or attributes

which can be used to define the subject to be coded.

The coding process consists of assigning a symbol or group of symbols to each item in a list of items, so that any item being coded can be identified conclusively from all the other items which appear in the list. Perhaps the list of items to be coded has been put together in a completely random fashion, or alternatively, it may be classified, so that the order of the items in themselves is meaningful.

However, amongst so many coding systems used on site the following are the most common ones (refs.14 & 82).

i) *Alphabetical Symbols Systems*

This type of system uses alphabetical symbols for identifying the items in groups.

Using a purely alphabetic coding system has the distinct advantage that so many symbols (letters) can be used for coding, also it is easy to represent a characteristic or an attribute by using the initial letter of that characteristic's or attribute's name.

The disadvantages are; they suffer from the fact that there tends to be more errors in transcription when using these symbols, and they are certainly more difficult to speak and write when combined to form a long code word which is not easily pronounceable as a whole.

ii) Numerical Symbols Systems

This system uses numerical symbols as a way of identifying the items. The advantage of purely numerical systems is that numbers are better understood and are more meaningful when it comes to rating precedence and order. Its drawback lies in the limitation that there are only 10 symbols, (0 to 9) which mean that only (10) variations are available at each position in the code number.

iii) Combined Coding Systems

A combination of numerals and alphabetic symbols in code words is not of very great value in a business coding system and generally suffers from most of the combined disadvantages outlined above, whilst having few of the advantages.

There are common instances of these combinations in current use. The system for allocating registration numbers for motor vehicles in the United Kingdom is the most obvious example, where it is found either desirable or necessary to combine the two types of symbols, it is found that each type of symbol rather than allowing a free group of mixture of the two is better grouped together. It is also found that the problem of differentiating between number and letter is less acute in this instance.

Having made a decision about the type of symbol that will be used to represent the attributes of the subject to be coded, it is then necessary to establish the rules by which the code words will be constructed and what the meaning of each digit in the word will

be. However, there are so many different methods of coding (ref.14), it can be according to random fashion, form of mnemonic or standard classifications like breakdown levels or level of responsibilities, bill of quantities classification, method of measurements (like CESMM (refs. 19 &20), SMM6/7 (ref. 18)) or operational coding method (ref. 11).

2.2.8) Policies to Facilitate Site Control

There are a number of general policies which should be adapted in order to increase the effectiveness of a site control system, these are, (ref. 14):

i) High Morale

An organization is unlikely to continue to operate at a profit even with the existence of high monetary rewards for employees, without the rather subtle and intangible factor of morale. The rewards for work must include not only economic incentives, but also those which stem from participation, from doing an agreed job, from belonging and self satisfaction. These are characteristics of morale, a necessary ingredient for efficient performance.

ii) Management Support

Any action which is to be carried out successfully in a construction firm must be supported vigorously by management. This is a factor which must be given high priority.

It is the management who are responsible for planning and

coordinating the effort of its employees. This responsibility includes successful leadership.

iii) *Understanding*

One of the difficulties later encountered in obtaining the cooperation of the employees in the administration of a site control system is the apparent lack of understanding of the objectives and uses of the system. Few persons are likely to carry out an assigned task with ardor and zeal unless there is an appreciation of how the individual parts fit into the whole.

Time should be made available (in the form of individual or group conference) for explaining the objectives and uses of budgets and the cost control systems, how they will be administered, the intent of flexibility and the way in which they will be employed in assessing the employees performance.

iv) *Participation*

It is important to provide the employees with an opportunity to make suggestions regarding all phases of work life. This is true because no one in the company will know as much about a particular job as the individual performing that job.

v) *Good Communication*

This is definitely an important factor in human relations, with previous good communication the job will be administered smoothly.

vi) *Attainable Targets*

It is true that many people readily accept challenges involving actions which they consider difficult, if it appears possible such actions can be successfully completed.

People naturally take pride in accomplishing an especially difficult task. Thus when setting targets one has to set targets which can be attained with vigorous pursuit.

vii) *Responsibilities*

Each member of the company must be clear on his or her responsibilities.

viii) *Rules of Being Reasonable*

Budgets should be administered fairly and reasonably to individuals.

Flexibility should be a continuing objective. It is important to note that controlling cost in accordance with the budget requires a good deal of tact and diplomacy, for example if you ask a hard-working man to explain unavoidable deviations, you will only cause possible bad feeling which will result in resistance to the budget.

2.2.9) A Check List on Site Control Systems

The following are some important designing points to note in any site control (ref. 3):

- is the costing system adequate in general terms ?

- does information from the cost control system highlight the critical factors that govern the company's success in achieving its objectives ?
- do good relations exist between the accounting staff and line management (if not why not) ?
- is cost control information geared to the requirements of responsible individuals ?
- do control reports cover both financial and related causal factors ?
- are cost control requirements and reports discussed with recipients ?
- are control reports brief, simple to read and relevant ?
- are actions taken on the basis of these principles ?
- are control reports used to indicate relative efficiencies?
- is the cost control system more complex (hence more expensive) than is necessary ?
- do all employees understand the cost implication of their work ?
- do all employees have cost targets (where relevant) ?
- do all who require it receive cost information ?
- do those individuals charged with various costs really have control over those costs ?
- do recipients of control information know how to extract the most essential facts ?
- are cost controls established according to the nature of the tasks ?
- are deviations reported rapidly ?

- do controls conform to the organizational structure ?
- are cost controls flexible and economical in operation ?
- do controls help to explain variances and to indicate the correction that is required ?
- does the cost control system have the active backing of top management ?
- is the system seen as being an essential part of the company's management process?
- does the basis of measuring desired performance reflect those aspects of output and input that are important ?
- do responsible individual accountants play a full role in setting cost levels ?
- is the principle of management by exception followed ?
- are results measured in accordance with the same units of measure in which the standards are set ?
- do the benefits of the control system outweigh its costs?
- are unnecessary reports eliminated, and are new ones introduced only when clearly needed ?
- is the control system revised each time an organizational change takes place?

2.2.10) Requirements for Efficient Site Control Systems

These are some important points which are required to be considered by an efficient site control systems (ref.3):

— project control requires periodic reports to monitor the

project budget and then forecast cost and commitment. The reports must be consistent, easy to use and in a format for convenient comparison;

- it is also intended to provide such management information on a weekly and/or a monthly basis. It is envisaged that the system will run as part of an integrated management system and also it could be designed to function on a stand-alone basis;
- reduce the high clerical input normally associated with costing systems;
- reduce the duplication of measurement and calculation that is common at site levels;
- reduce the delays that occur in circulating management information to the relevant people;
- the system must provide historical information for estimators and planners;
- for ease of data collection and cost monitoring, it is intended that the cost centers (which group the bill items) should be either trades (for Building work), or the activities (for Civil Engineering);
- the system is intended only to indicate overall good or bad performance of a cost center, with some comments from the responsible site personnel to list some of the suggested causes, leaving site management then to propose the necessary corrective actions that may be taken.

From the above review and as a result of this literature survey, I have developed my questionnaire to the construction companies

(which are interviewed) on the site control systems they use to identify the efficiency and integration characters of their systems comparing with the literature, as explained in the second part of this chapter.

2.3) SITE CONTROL SYSTEMS CURRENTLY USED

The second part of this chapter explains the survey of thirteen construction companies in U.K., as a representative sample. To make this sample as comprehensive as possible I have selected these companies deliberately to be in different sizes (from very small of £1 million turn over, to very large of about £350 millions). I have also selected these companies to be of different nature of construction work (Civil Engineering and Building work), and from all over U.K. regions. So that these companies, as a sample, have well presented the construction industry in U.K., despite the size, the nature of the construction work and the region of the working site of the construction company in U.K.

The survey was undertaken by interviewing the companies, using a questionnaire developed from the previous literature review (as explained in the first part), to examine the efficiency and the integration characters of the site control systems that the construction companies use. The questionnaire has included a set of questions on the characters of companies' site control systems as shown listed in the top of figure (2.3), the answers of the companies on the questionnaire are listed underneath in the same figure. The name of the companies have not been mentioned

COMPANY SIZE	COSTING SYSTEMS AIMS	PERIOD LONG FOR MONITORING REPORTS	CODING SYSTEMS BEING USED	LEVEL OF SPLITTING OUT THE FIGURES	BREAKDOWN FIGURES OF THE MONITORING REPORTS	WAY OF COLLECTING THE DATA	THE STANDARDS OF COST COMPARISON	SYSTEMS FEEDING METHOD	WAY OF PREPARING AND UPDATING THE ESTIMATES	LINKING FACILITY OF THE SYSTEMS	AVAILABILITY OF FEEDBACK TO ESTIMATOR FACILITY
A	Medium • Monitoring project cost budget	One month-two weeks for preparing reports	Not considered	To the 4th level of the company organization	None (comparing against quantities)	Manually	BoQ item quantities	Stand-alone	Not considered	Not available	Not available
B	Small • Cost monitoring for labour and bonus costs	One month time	BoQ Coding system	To the 4th level of the company organization	-Labour -Bonusing	Manually	BoQ Item rates	Stand-alone	Manually	Not available	Not available
C	Large • Cost monitoring • Cost/Value reconciliation • Resources forecasting	One month time	Six digits coding system (Area, group, Item) two each	To the 4th level of the company organization	-Labour -Plant	Via micro computer	Rate variances	Stand-alone system	Not considered	Not available	Manually
D	Medium • Monitoring Costs • Forecasting	One month time	Not considered	To the 4th level of the company organization	-Labour -Plant -Material	Manually	BoQ Item rates	Stand-alone	Not considered	Not available	Available
E	Large • Monitoring project costs • Indicating lossing area	One month time	Four Digits Coding system (groups, resources)	To the 4th level of the company organization	-Labour -Plant -Material	Manually	BoQ Item rates	Stand-alone	Not considered	Not available	Not available
F	Medium • Quality monitoring for labour and plant • Cost monitoring for material • Forecasting final costs	One month time	BoQ Coding system	To the 4th level of the company organization	-Labour -Plant -Material	Manually	BoQ Item rates	Stand-alone system	Not considered	Not available	Available
G	Large • Cost monitoring • Indicating problems area	One month time	Activity Coding system	To the 4th level of the company organization	-Labour -Plant -Material -Profits/Overheads	Manually	Tender estimates	Stand-alone system	Not considered	Not considered	Not available
H	Large • Output control for showing profit and loss figures	One month time	BoQ Coding system	To the 4th level of the company organization	-Labour -Plant -Material -Subcontractors -Preliminaries -Overheads/Profits	Manually	Tender built-ups	Stand-alone system	Tender built-ups	Not available	Not available
I	Large • Cost/Value reconciliation • Cost monitoring • Cost forecasting • Performance indicating	One month +15 days for preparing reports	Cost Center Coding system (max. 25 cost centers)	To the 4th level of the company organization	-Labour -Plant -Material -Preliminaries	Manually	Tender estimates	Stand-alone system	Manually	Not available	Not available
J	Small • Valuation (output) • Cost/Value comparison	One month time	CEMM Coding system	To the 4th level of the company organization	-Labour and/or plant -Material -Subcontractors -Preliminaries	Manually	BoQ Item quantities	Stand-alone system	Not considered (deals with quantities)	Not available	Manually
K	Large • Anticipate cost estimate for site control and future tendering	One month time occasionally fortnightly	Not considered	Trade heading and then into compounds	-Labour -Plant -Material	Via micro computer	Value of work expected	Stand-alone as well as linkable to other systems	Manually	Not available	Manually
L	Large • Costs, values, salaries (accounting system)	One month time	BoQ Coding system	To the 4th level of the company organization	It works for Labour and plants separately	Manually	Tender costs and costs of final completion	Stand-alone system	Manually	Not available	Manually
M	Large • Cost/Value variance • Forecasting • Feedback of estimator • Graphical reports	One month time	Created Coding system	To the 4th level of the company organization	-Labour -Plant -Material -Subcontractors -Non-mechanical plants	Via micro computer	Direct costs in tendering stage	By accessing data from other systems	Manually	Not available	Available

FIGURE 2.3: A DETAILED TABLE SHOWS THE CHARACTERS OF THE CONSTRUCTION COMPANIES' SITE CONTROL SYSTEMS BEING USED

according to their request.

According to the survey, the following conditions have been reached in practice (ref. 4):

- all the thirteen companies regardless of size, were using systems for monitoring their budget costs more than for controlling the site. This made their site control system, an accounting system whereby budgeted costs were compared after the activities were completed;
- eleven companies were using systems which gave an indication of whether a profit or loss would be made on the overall project, this appeared to be the simplest and cheapest system to use;
- eleven companies still appear to have a problem of collecting data for their systems as this requires money and sometimes large numbers of staff need to be employed, preparing reports on their system on a monthly basis only helps to reduce the time required for collecting the data;
- due to the reasons outlined in the first one above, there is no specific coding method being used with the system. Four companies have created their own coding system related to areas of work or to resources, the other three use Bill of Quantities coding system, while the remainder have no coding system at all;
- twelve companies have a system whereby the forth level of project management (i.e. General Foreman) receive a report;
- a variance exists in the level of breakdown figures provided by the different systems. Seven companies use systems

- giving reports of up to three breakdown figures (i.e. labour, plant, material), the other five have four breakdown figures and one of the companies had a system giving a report of the overall project without any breakdown figures;
- all the systems being used, apart from one, required the re-entry of the cost control data manually which influenced the time in producing reports by informing them about the results of this monitoring;
 - all the systems used selling prices (bill of quantities item figures) as their standards;
 - despite the importance of updating estimated costs to keep the monitoring procedure as effective as possible, eight systems do not consider this in monitoring by comparing actual cost to the budgeted cost without any updating;
 - only one out of thirteen companies had systems giving feedback reports for estimators.

2.4) CONCLUSION AND OBSERVATION

From the comparison between the existing knowledge in the literature on the site control and management aspect, and the construction companies site control systems being used, I have identified the following observations on the existing systems, which are required to be considered in any attempt to improve the efficiency and the integration in the systems currently used, these observations are:

- site management in the construction industry still has not

reached the integration because;

- a) there are no facilities for data sharing between the different management systems (e.g. Estimating, Valuation, and Site Control).
 - b) the site control results have no facility to be sent back to the Estimator (i.e. no feedback).
 - c) even on the site, there is no passing of the data between the different project personnel (on and off the site).
- construction companies site control systems are still very simple, mostly accounting systems, with very little facilities for monitoring the site, as their reports come out after the operation has been executed.
 - site management is also still suffering from the deficiency, as most of the efficiency requirements are still missing such as: providing periodical reports of site control, historical information for the Estimator, reducing clerical input, providing the weekly/monthly management information and reducing the duplication of the measurement and the calculation on site. These requirements have not yet been achieved by construction company site control systems.
 - any site control and monitoring system should provide most, if not all, of the following controlling data on site:
 - a) cost/value variance data;
 - b) overall project data for preliminaries;
 - c) forecasting data (for operations not yet completed and the estimate of project cost at completion);
 - d) cost center item list;

- e) feedback data to the estimator;
 - f) short term planning and control data;
 - g) material reconciliation and/or utilization data;
 - h) graphical data.
- to make monitoring and controlling procedures effective, the site control system should have a coding system which lists the cost centers to which all the expenses on the project are related. This should ease the method of controlling and make it more efficient;
 - the number of breakdown figures should preferably be at least four (i.e. labour, plant, material and subcontractors), this may vary from one company to another. Preliminaries should also be considered as one of the resources on the project which include plant running costs, temporary works and non-mechanical costs (all expenses not included elsewhere);
 - in addition to the above, the following points should be considered in developing an efficient site control system:
 - a) the cost control form must be easily understood and easy to complete;
 - b) the management team within the company must be aware of their responsibilities and full co-operation within the team is crucial;
 - c) good planning must not be neglected;
 - d) good relationships should be maintained with all the parties included in the contract (i.e: the Workforces, Subcontractors, Engineers, Architects, Local Authorities and the Promoters/Clients);

e) good communication and co-operation is important.

At the end of this chapter, two research surveys have been undertaken. The first survey was on the existing knowledge of site control and management in literature. The second one, on the construction company's current site management systems and the company requirements from an integrated and efficient system.

CHAPTER THREE

CHAPTER THREE

COMPUTER SOFTWARE FOR CONTROLLING CONSTRUCTION PROJECTS

3.1) INTRODUCTION

Although it takes more than a computer and a project management program to manage projects effectively, the advent of project management software has revolutionised the practice of project management and has helped project managers do their job better than they could in the past.

Some of the functions involved in project management particularly those having to do with project control were virtually impossible to execute with any consistency before computers were used.

In the first part of the research survey (as explained in chapter two), I have identified that computer-aided construction management has not achieved the requirements of efficient site management. All the available site control software still suffers from a lot of gaps which made the developing of an efficient site control software one of the problems that still requires a considerable amount of attention by the computing company.

This chapter explains the second part of the research survey which was done as a questionnaire that has been developed from the requirements of the construction companies to identify the

problem of improving the site management in the construction industry to make it more integrated and efficient as explained in chapter two.

The chapter has been divided into two parts. The first part explains the requirements of the construction companies in an integrated and efficient site management system. Their requirements were collected from interviewing thirteen construction companies, the same companies that have been surveyed to identify the systems being used and their efficiency and integration according to the literature (as explained in chapter two). In the second part, I have used these requirements to develop another questionnaire which was used to identify the site management facilities that can be provided by the site control software available in the market and how far it could achieve the construction industry requirements.

At the end of the chapter, the missing link between the literature review and the construction industry from one side, and the construction industry and the computer-aided construction management software from the other side has been identified. From that the "Business Requirements" specification for an integrated and efficient site management system has been established as one of the main objectives of my research, on which I have depended, in developing my "computer-aided" software model to fulfill the promise of an efficient and integrated site management and achieve these requirements as explained in chapters four and five.

3.2) USING COMPUTERS IN CONSTRUCTION MANAGEMENT

Before going through the first part of this chapter, this review has been added to give a historical use of computers in construction management with the problems that appeared and how they have been solved, to help in understanding the current problems.

Computers have been utilized in the construction industry for some time, notably in the fields of structural and engineering design.

However, the use of computers for management applications seems to have been strongly resisted by contractors in the past. There are many reasons for this but one has been the fact that, in the early days, only central mainframe computers were available. This created a physical and psychological distance between site and computers, and the communication problems with remote computers did not make their application worthwhile.

The advent of the mini and microcomputers should have changed that. Yet despite the fact that computing power is becoming less expensive all the time, computers still appear to be grossly under-utilized in the construction industry. Only 17% of the European Construction Industry use computers to some degree with no indication of any attempts of using computer-aided site management systems (ref. 63).

Two surveys of interest carried out in 1979 (ref. 64), showed

that the majority of computer programs available covered only the areas of:

- Estimating.
- Planning/Network Analysis.
- Cashflow Forecasting.

More recently, in 1984 (ref. 49), this was seen to have expanded to include

- Valuation
- Accounting

The estimating systems have grown dramatically (ref. 49), there are currently in the U.K. some thirty to forty different computer-aided estimating systems.

Planning is also considered now as one of the longest established application areas of computing, and has changed relatively little in the last five years. The same can be said about cashflow forecasting.

The valuation systems vary greatly in their levels of facility and sophistication, it has reached its best in a package developed at Loughborough University of Technology (refs. 57,62), called "PLUS VAL" which claimed to be integrated to Estimating system as well as applicable to access the valuation and measurement data to the Site Control system, as explained in chapter five.

The accounting packages are largely designed for financial

accounting (at the company level) with only nominal facilities for contract costing. Generally these systems consist of one or all of the following modules (ref.49):

- Payroll
- Purchase Ledger
- Nominal Ledger
- Sales Ledger
- Subcontractor Ledger
- Contract Costing

With the exception of a few programs like "Project Cost Model", which lay claim to being a project cost control system, there is no system that could be called an efficient and integrated site control system. The required site control system is expected to be an efficient system of accounting, monitoring, controlling and forecasting the cost as well as the resources performances and which can be linked to the other construction management systems of: estimating, planning, cashflow forecasting and valuation, to give the facility of accessing the data to/from the system.

So far, the majority of the available software was being developed on a "stand-alone", basis, in other words, it is self-contained and depends entirely on a manual input of all data, to produce its output.

By and large, this is a pity, because the construction process is distinguished by the high level of repetition carried out by a contractor's various departments in estimating, recording,

measuring and calculating costs and quantities. Computerizing on a stand-alone basis may speed up the processes, but it also serves to perpetuate the situation. Further, computers may aggravate the situation in that they can often defeat the purpose of their application. Clearly there is a need to rationalize the computerization of the industry as well as some of its procedures.

A solution, long proposed now, to this problem is the integration between the various construction management programs by means of sharing the data files or passing data between them. This will end in an integrated site control system which will allow the data to be entered once through the estimating stage to be used for different purposes, and the real on-site data will be sent back to the estimator as a feedback from the site for updating the estimates. It is this integration which poses problems to the application of computers in construction management.

These problems of deficiency of using a computer-aided integrated site management system for construction projects as highlighted above are explained through this chapter.

3.3) CONSTRUCTION COMPANY SOFTWARE REQUIREMENTS

This part of the chapter, as mentioned in the beginning, identifies the requirements of the construction industry in an integrated site management system. This survey is based on the same interviews of the thirteen construction companies used in chapter two before.

The survey revealed the following requirements (ref. 57);

1. All the companies asked for a complete construction management software system which has the ability to be used for any size of contract at any site conditions.
2. Any computer software must be able to provide all the facilities that might be required on site to control and monitor the cost and expenses of the project while it is being executed. These facilities are:
 - (a) cost/value reconciliation data;
 - (b) preliminaries reconciliation data;
 - (c) cost forecast for work not yet done;
 - (d) feedback information to the estimator;
 - (e) short term planning (STP) controlling information;
 - (f) material reconciliation and utilization information;
 - (g) graphical reports in addition to figures for the reconciliation data above.
3. Most of the companies requested a software system which could provide a report to the fourth level of management responsibility in the company (i.e. Foreman level), to make their monitoring system more efficient in indicating the precise area of loss.
4. The companies preferred to have a software system which could provide reports that are simple, detailed and easily understood with the minimum number of staff required for collecting the data.

5. There was a marked variation in the answers to the question on the breakdown figures of analysis required, depending on the size of the company and the project. However, all of them were satisfied with six breakdown figures of analysis as a maximum which are: labour, plant, material, subcontractors, preliminaries and overhead.
6. All the companies appeared to be confused by the reports presented by the systems as most of the software gave reports and analysis as lists of figures.
7. The majority of the cost of any controlling system was expended on staff time, therefore all the companies asked for software which required the minimum amount of staff and time.
8. All the companies preferred to have integrated software covering all the management aspects such as estimating, valuation, planning, forecasting, cost monitoring and control, or at least to have software systems capable of being linked together whenever required. This would reduce the number of staff needed as well as the time of accessing the required data from one system to another.
9. Companies required more efficient software capable of updating data automatically within the system so that a minimum number of staff can be employed and less time spent.
10. All the companies required the control reports to be monthly, sometimes fortnightly, or even weekly for large

contracts.

11. All the companies preferred to have graphical print out with the control reports showing them the level of expenditure graphically as well as figuratively. This makes it easier and quicker for the project manager and the section engineer to monitor expenses.
12. In answering the question on the coding system preferred, different answers appeared depending on the size of the company and the nature of the project. Some of them preferred a Bill of Quantity items coding system, while others preferred any coding system which could be used interactively with the software package.
13. All the companies asked for a feedback report facility for the estimator to assist in updating future estimates. This also provides a good report of the variances in the costs, and from the estimates which enables a "cost to complete" forecast to be provided for the project.

From the above list of the companies' requirements, I have developed another set of questions in a questionnaire form and sent them to the computing companies (which have developed site control software) to identify the facilities which can be provided from these software compared with the construction company requirements, as explained in the second part of this chapter.

3.4) SITE CONTROL SOFTWARE PACKAGES AVAILABLE

This second part of the chapter consists of a survey of eight site control computer software packages available

in the market by using a questionnaire developed from the construction company's requirements in an efficient and integrated site management system, as explained in the first part of this chapter. The site control software have been selected as they are the latest developed software in the market according to; the Construction Computing magazine issues, CICA (ref. 49) and Construction Computing Exhibitions (at; NEC, Birmingham, October 1987 and Barbican Hall, London, April 1988). The questions which were included in the questionnaire are shown in the top of figure (3.1), whilst the answers of the computing companies (as their site control software facilities compared with construction company requirements) are listed in the same figure as a table underneath. From the findings of this survey, the "Business Requirements" specification were established (as a conclusion of this survey), as a basis for developing an integrated and efficient site management system.

According to the survey the following findings have been identified (ref. 57):

1. None of the software available can provide all the requirements mentioned previously in the first part of the chapter. They all differ in their outputs, providing some requirements and missing others.
2. The question about the coding systems used by the software, revealed that two of them offer the option of either Bill Items coding, Civil Engineering Standard Method of Measurement (CESMM) coding and Operational Bill coding, whilst the rest either use Bill Items coding

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only or do not have a coding system.

3. Only three packages can provide reports to the fourth level of company organization (i.e. Foreman), whilst the others provide reports to the third level (i.e. Section Engineer).
4. Six packages can provide reports of 4 levels of analysis (i.e. labour, plant, material and sub-contractors). None of them consider the preliminaries to be one of the important figures which need monitoring.
5. One of the most important facilities missing in available software is a method of automatic data feeding into the system where the user still has to re-enter the data manually, every time it is required in the systems, instead of accessing it from other software's data files, and that would save in staff and time required.
6. The facility to link with other software systems such as estimating, planning, valuation, bonusing, material control etc. is still not as integrated as required.
7. Three systems do amend and update data automatically within the system without re-entering data in addition to the usual manual updating facility.
8. Only one software package out of eight can provide graphical reports for monitoring purposes.
9. All the software can produce cost/value reconciliation reports which is the most useful facility provided.
10. Five software packages can provide cost/value reconciliation reports for each valuation/measurement period as well as for cumulative valuation/measurement.

11. Although forecasting reports are very important, only two out of eight software packages can provide reports on individual activities not yet completed as well as on project cost estimates at completion by which we can control the costs more precisely as well as giving a wide view of the cost of the project as a whole.
12. The computer language might not be that important but it is preferable to have software packages working from more popular computer languages (i.e. Basic or Fortran). That might create more opportunities to link systems to each other even from different computing companies.
13. Fig. 3.1, indicates the number of users of the software packages. It shows that the number of construction companies in the U.K. using these software packages is very small, which means the remaining companies are either using their own systems or do not have a computing system at all.

3.5) CONCLUSION AND OBSERVATIONS

From the review of the chapter, two points have been examined concerning the problem of having an integrated site management as part of an integrated construction management system and how the "computer-aided" construction management systems can assist efficiently. These points were:

1. what the construction companies require from the computer-aided software to achieve;
2. what site management software is available and what

facilities they offer.

At the end of this chapter and as far as these two points are concerned, I have concluded the following points as "Business Requirements" specification for developing a site management system. The specification is:

- _ The available software is still not as adequate, efficient and integrated as expected, because:
 - * the site control software could not achieve so far the requirements of the construction industry as it is still inadequate for achieving the integration required in the site management, because it is still mostly a self-contained system that has not got the ability to accept or access data;
 - * there is a big shortage in the control reports on site and the reports that can be provided from the available software are not efficient in indicating the loss making operations;
 - * the control data provided by the available software appears after the operation has been executed, that makes the controlling procedure on site efficient;
 - * there are still some deficiency points in the available software such as:
 - a) it does not reduce the number of staff required on site;
 - b) it does not consider the site practices (e.g. claims, variation orders, daywork and price fluctuation);

- c) the presentation of its control reports are very poor and difficult to understand;
- d) there is no reduction in the duplication of the data entry through the software;
- e) the data updating is still done manually outside the software.

- _ Any attempt to develop a site control software must achieve the construction industry requirements as its objectives, the literature must also be considered as theoretical guidelines in that attempt. The contribution of the computing people must also be considered to achieve the required efficiency in operating such software by using the "computer-aided" techniques and their programming experience software.
- _ The simple way to succeed in having an integrated system, at least in the short term, is to adopt a series of separate functional systems without worrying about integration. Even if the chosen package offers integration it may be better to operate in a non-integrated fashion until real problems of the integrating system are tackled.

CHAPTER FOUR

CHAPTER FOUR

A DESCRIPTION OF PLUS COST

4.1) INTRODUCTION

From the research survey which I have undertaken to examine the adequacy of the available site management software as integrated and efficient as expected by the construction companies (as explained in chapters two and three), the first two objectives of the research have been achieved. I have concluded that the site management software is still inadequate in the sense of integration and efficiency, and the use of computers still behind in solving this problem. To help solve this problem, there are a set of requirements "Business Requirements" specification, that must be considered in any attempt of developing a "computer-aided" software for a site management system. These requirements (as listed in chapter three) are demanded by the construction companies to be achieved by using a computer-aided site management system, so that using the computer in this field of construction management (site management) will reach the same development that is in the Estimating, Valuation, Planning and Cashflow Forecasting fields.

Having achieved the first objective of the research, the other objectives have then been fulfilled. I have developed a computer-aided software model called "PLUS COST" (site management PLUS COSTing), linkable to Estimating, Planning,

Valuation systems. "PLUS COST" is expected to achieve the "Business Requirements" specification of having an integrated and efficient site management system, by filling the gaps that I have identified from my research survey such as; data sharing between the construction management systems, accessing site controlling results data back to the Main Office and better control reports on site to control the cost and the performance of the overall project and its resources efficiently.

By developing "PLUS COST" and using it on site as an integrated site management system, the rest of my main research objectives of having an integrated site management system linked to the other construction management systems as well as achieving an integrated use of the site control data between the site and the Main Office, will be reached. Also through "PLUS COST" all the secondary objectives of the research (as listed in chapter one) will be achieved.

This chapter explains only the general features and the specification of "PLUS COST" in brief and the functions it can achieve. Some of these functions such as: calculation of claims, variation orders and price fluctuation are in existence in the valuation systems as valuation functions, but in "PLUS COST", they are included to work as control functions for adjusting the on site figures for the cost/value reconciliation. A few of the other control functions exist in the available site management software, but are not as efficient in controlling the site as in "PLUS COST" (as explained in the following chapters).

The description of "PLUS COST" software general features is provided under the following headings:

- System's General Description;
- Price Adjustment for Inflation;
- Starting a New Contract on The System;
- Working on an Existing Contract.

Through this chapter, the description of these headings and the system entry is explained briefly with the integration and site control functions available under each heading, while the following chapters (chapters five to ten), will describe these functions in detail and explain the reasons behind their essential existence in "PLUS COST". Also this chapter explains some general features which I have developed in "PLUS COST", to increase the efficiency of achieving these functions. The chapter then explains the proposed way of using "PLUS COST" on site to operate efficiently. Lastly the chapter describes the costing and the controlling tasks of "PLUS COST" with its internal procedures for achieving each of these tasks.

4.2) GENERAL DESCRIPTION

I have developed "PLUS COST" as a software model to provide facilities for achieving the following functions for both Building and Civil Engineering contracts:

- * accepting the estimating and valuation data accessed from the other construction management systems;
- * contract price adjustment for inflation;

- * cost accounting of the contract;
- * costing and performance control of labour and plant on site;
- * the provisions of information for the management of material purchasing, utilization and usage on site;
- * preliminary control on site (both, preliminary items and in-rate);
- * sub-contractor's site costing and control;
- * value/cost adjustment on site for claims and variation orders;
- * the provision of information for cost/value reconciliation;
- * the provision of feedback information to the estimator and the upper levels on/off site of the construction organization;
- * the provision of information for short term planning and control to the section engineer;
- * the provision of information for cost forecasting;
- * it is also a data base system providing site information on claims and variation orders and their valuation for both main and sub-contractors.

PLUS COST is composed of 22000 lines of ANSI FORTRAN 77 code which take up (430) kilobytes of memory. The system is currently held on a PRIME 750 minicomputer at Loughborough University of Technology.

4.3) PRICE ADJUSTMENT FOR INFLATION

"PLUS COST" aids price adjustment for inflation as one of the value and cost adjustment functions on site, by the formulas used for both Civil Engineering and Building contracts. The tasks required to be undertaken by the user are described in chapter nine. These tasks are data capture and maintenance of the appropriate files of indices.

The system aids the user in the performance of these tasks by:

- prompting him to type in the appropriate indices as and when they become available;
- storing the indices typed in;
- providing the user access to indices already stored for inspection, amendment or deletion.

These indices are required to be entered before starting to use the system for costing purposes as explained in chapter nine.

4.4) WORKING ON A NEW CONTRACT

Through this heading, "PLUS COST" will let the user work on a new contract not entered before. "PLUS COST" can support up to 5 contracts.

The data entry of adding a new contract starts after the system has been entered successfully and the option "To Work On a New Contract" has been selected from a list of four headings. Once the right option has been selected, "PLUS COST" will prompt the user

to type in the general data of this new contract which includes data about the contract, the client, the Architect/ Engineer and the Contract Total as shown in figure (4.1). I have learned from my research that this general data of the contract is essential to identify any contract from the contractor's point of view. To make the system as secure as preferred, I have developed "PLUS COST" to require two passwords for operating the system, one at the beginning before getting into the system, and one for each contract in the system, so that only the people who know the passwords can use the system.

If the user selects to file the data, the system will store the data as typed-in data and take him to the "Main Menu" of the system to let him enter the data on the contract which already exists, as shown in figure (4.2).

4.5) WORKING ON AN EXISTING CONTRACT

To gain access to the control functions of the system or to get any information on a contract entered before, the user needs to know the contract number and its password, and the system will then take him to the Main Menu of the system after showing the required contract general data on the screen making sure it is the right one.

In the Main Menu of "PLUS COST", I have included the following options, figure (4.3):

- Data Preparation;

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 2

Contract No. ? 1

Contract Password ? BUILD

Contract Title ? BALFOUR BEATTY CONSTRUCTION CRS SYSTEM

Contract Registration no. ? B B / 890

Client's Name ? BALFOUR BEATTY CONSTRUCTION CO.

Client's Address ? 55 MANSFIELD STREET,
DERBY
DERBYSHIRE,
UNITED KINGDOM

Consultant's Phone no. ? DERBY 253871

Consultant's Contact Person ? JOHN SMITH

Architect/Engineer Name ? J. WALKER

Address of Architect/Engineer ? 57 BUCKINGHAM DRIVE,
DERBY,
DERBYSHIRE,
UNITED KINGDOM

CONTRACT TYPE (CIVIL/BUILD) ? BUILD

CONTRACT TENDER TOTAL ? 9826543.98

FIGURE (4.1); DATA ENTRY- NEW CONTRACT GENERAL DATA

```

CONTRACT TITLE      : BALFOUR BEATTY CONSTRUCTION CRS SYSTEM
CONTRACT REGISTRATION NO. : B B / 890
CLIENT NAME        : BALFOUR BEATTY CONSTRUCTION CO.
CLIENT ADDRESS     : 55 MANSFIELD STREET,
                   : DERBY
                   : DERBYSHIRE,
                   : UNITED KINGDOM
CONSULTANT PHONE NO. : DERBY 253871
CONSULTANT CONTACT PERSON : JOHN SMITH
ARCHITECT/ENGINEER NAME : J. WALKER
ADDRESS OF ARCT./ENGIN. : 57 BUCKINGHAM DRIVE,
                   : DERBY,
                   : DERBYSHIRE,
                   : UNITED KINGDOM
TYPE OF CONTRACT WORK : BUILD
CONTRACT TENDER TOTAL : 9876544.00
=====

```

```

AM -----To amend
QU -----To quit
FI -----To file

```

```

Which do you want ? FI
Contract data has been filed.

```

```

Press <CR> to go to the main menu .

```

```

*****< Main Menu >*****

```

```

Options:-
-----

```

```

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

```

FIGURE (4.2); DATA MAINTENANCE- NEW CONTRACT GENERAL DATA

```
To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5
```

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

```
CONTRACT NO.:          1
PROJECT:              BALFOUR BEATTY CONSTRUCTION OPS SYSTEM
CLIENT:              BALFOUR BEATTY CONSTRUCTION CO.
                   55 MANSFIELD ST.
                   DERBY,
                   DERBYSHIRE,
                   UNITED KINGDOM
ARCHITECT/ENGINEER:  J. WALKER
                   57 BUCKINGHAM DRIVE
                   DERBY,
                   DERBYSHIRE,
                   UNITED KINGDOM.
TYPE OF THE WORK:    BUILD
```

=====
Press <CR> to go into the system.

*****< Main Menu >*****

Options:-

```
-----
Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14
```

FIGURE (4.3); SHOWS THE ENTRY INTO THE EXISTED CONTRACT

- Bonusing Indices Data;
- Labour Control;
- Plant Control;
- Material Control;
- Preliminary Control;
- On-Cost Overheads Control;
- Daywork Sheets;
- Claims;
- Variation Orders;
- Preparing Reports;
- Feedback Comments;
- Exit.

The achievement of the site management requirements through each option is explained briefly as follows.

4.5.1) Data Preparation

This transaction builds up details of all the data which may be accessed from other construction management systems of: Estimating, Planning and Valuation, if they are available to be linked to "PLUS COST", so that the integrated data required to be entered through this option will be accessed from these system's data files. Thus there will be no need to go through this option, as explained in chapter five. This data is:

- Bill Item Data;
- BoQ Valuation Data;
- Resources Data;
- Sub-Contractor's Data;

- Cost Center Data;
- Section's Data;
- Unfixed Material Data;
- Engineer's Assessments for Price Adjustment.

The data will then be used through the system for costing and site controlling procedures, so that the user has to select this option as the first step before going through the other transactions (options), in case there is no access for this data from the other systems as mentioned above.

Through this transaction, I have developed "PLUS COST" to achieve the requirements of having a site management system which can operate as an integrated system as well as being self-contained, when it can accept data accessed from other management systems such as; Estimating, Valuation and Planning. By entering this data manually at the beginning of this transaction the system will be stand-alone (self-contained). The using of this transaction and the data required is explained in detail in chapter five.

4.5.2) Bonusing Indices Data

This transaction prompts the user to enter the data about the incentive schemes used on site (if there is any) by typing in the bonusing indices which are suitable for the incentive schemes used for the labourers of that contract, as part of labour cost calculations.

This transaction is optional, if there is not an incentive scheme

working on site, for labour, the user need not to get into this option and the system will automatically leave out bonuses in calculating labour actual cost.

Three incentive schemes the user can select through this transaction, are:

- Piecework Scheme;
- Profit Sharing Scheme;
- Standard Bonus Scheme.

Through this transaction in "PLUS COST" , the value of the Bonuses for labour weekly according to the work done can be calculated, to be added to the labour basic cost of the working hours to produce the labour gross site cost.

4.5.3) Labour Control

Through this transaction, the system can calculate the weekly site cost of labourers and produce some on-screen control reports of labour productivity by using the site allocation sheets, from which the data about the labour working hours will be typed into the system weekly, so that the wages of labourers can be calculated automatically by the system. Both types of labour operating on-site systems can be provided by "PLUS COST" as Individual Labourers or Labourers in Gangs system.

4.5.4) Plant Control

The system prompts the user who selects this transaction to enter the data from weekly plant site sheets

(Time and Task sheets), for the purpose of doing the calculations for plant cost and producing the cost and utilization reports as on-screen weekly reports.

4.5.5) Material Control

PLUS COST provides this facility which allows the user to:

- * coordinate the purchasing and delivery of material;
- * monitor the usage of material and its wastage;
- * monitor the utilization of material;
- * get a summary of the used materials, the suppliers, orders and deliveries.

The system achieves this by storing and maintaining data on suppliers, purchases, orders, deliveries, stocks of materials not yet used, wastage and utilization allowances.

The control reports can be provided by the system as on-screen and print out reports.

The above four options are explained in detail in chapter six.

4.5.6) Subcontractor Control

As one of "PLUS COST" control objectives is costing and controlling subcontractors on site, this objective has been achieved through this option by providing data on:

- Subcontractor Weekly Payments;
- Monthly Liabilities of Subcontractors;

- Subcontractor Claims Registration and Measurement;
- Subcontractor Variation Orders;

The system will also do the required calculation to produce the actual cost of the sub-contractor to be used in producing the actual cost of the work done. This will then be compared with the estimated cost in the reconciliation reports of the project as a whole. The system provides through this option some on-screen reports of weekly letting margins, monthly liabilities and monthly accounting.

Chapter seven explains how this option can achieve the subcontractors control on site.

4.5.7) Preliminary Control

In this transaction, PLUS COST controls both types of preliminaries;

- BoQ preliminary items;
- preliminary in-rates of the BoQ items.

The first are the items which are considered as preliminaries in the BoQ as well as the items that can not be related to any cost center. The second are as one of the break down figures of BoQ item rates such as labour, plant, material and subcontractors.

The user enters the site data monthly, and the system will do all the calculations required for controlling both types of preliminaries on site and producing on-screen and print out

reports.

Chapter eight has a full description of this facility in "PLUS COST"

4.5.8) On-Cost Overheads Control

I have added this transaction to "PLUS COST" so that the user could type in all the additional costs on the labour wages and bonuses for calculating the total gross actual labour cost.

On-cost overheads are usually considered at the estimating stage as a percentage of estimated labour cost.

However, the user, through this option can type in the on-cost labour overheads weekly, as explained in chapter six, and the system will add them to the labour wages and bonuses to calculate the actual gross labour cost.

4.5.9) Daywork Sheets

"PLUS COST" prompts the user to type in any daywork data from the daywork sheets to be added then to the other costs in calculating the actual costs of the work done weekly.

The full description of this facility is discussed in chapter nine.

4.5.10) Claims Registration and Measurement

I have developed "PLUS COST" as one of the

site adjustment practices to deal with the losses and/or expenses type of claims only, and not extension of time claims. The system deals with both types of claims (accepted and not yet accepted). The system adds the values of accepted claims to the actual value of work done from one hand, and mentions that there is money that might come from claims not yet accepted with the valuation calculated on the other hand.

In this transaction, the user will be prompted to enter the data on the registration and measurement of claims which are for main contractors only. This is explained in chapter nine. The claim for sub-contractors is dealt with through "Subcontractor Control" transaction as explained in chapter seven. This option could exist in the valuation systems to calculate the value of the main contractor's claim for the interim valuation purposes, but not for controlling purposes as explained above.

4.5.11) Variation Order Registration and Measurement

Through this transaction, "PLUS COST" allows the user to enter the data on registration and measurement of the variation orders, and the system will calculate the value of these variation orders at each valuation to be added to the actual value to produce the actual gross value of the work done, and this value will then be used for producing controlling reports. The system prompts the user through this transaction to get on-screen reports on variation orders summary and accounts.

Chapter nine explains this transaction in "PLUS COST" and the way

of using it, as one of the value adjustment elements on site.

The variation order's calculation facility can exist in a valuation system for the same reasons as the claims which are mentioned in the previous option.

4.5.12) Preparing Reports

This transaction prompts the user to get a list of the following control and feedback print out reports from the data entered through the previous transactions as well as that data accessed from the other construction management systems and by doing some calculations inside the system. These reports are:

- Cost Monitoring Reports;
- Value Monitoring Reports;
- Cost/Value Monitoring Reports;
- Budget Costing Reports;
- Cost Center Costing Reports;
- Short Term Planning and Control Reports;
- Overall Project Preliminary Reports;
- Material Usage Reports;
- Estimator's Feedback Reports;
- Cost/Value Comparison Graphical Reports.

From the above list, a set of 18 control and feedback reports with an optional time period (weekly, monthly or to-date) can be provided in addition to those on-screen reports, so that an efficient and integrated controlling procedure of the project on

site has been achieved with the cooperation of the off-site personnel.

However, chapter eleven describes these reports in detail with an explanation of why these reports are essential to the construction organizations on/off site in controlling the projects.

4.5.13) Feedback Comments

Because feedback is considered as one of the important objectives of achieving an integrated site management system on site, as I have identified from my research survey on the adequacy of the site management system, I have developed "PLUS COST" to achieve this identification through the system for the purpose of reaching this objective by linking the system to the other construction management systems and sending the data produced by "PLUS COST" back to them.

"PLUS COST" can provide the feedback data to the upper personnel on/off site in two ways. In addition to "Estimator's Feedback Reports", as one of the reports that can be obtained from "Preparing Reports" option, "PLUS COST" has also this transaction, through which the user can add his comments (up to twenty comments each time) on any of the reports which are mentioned in section (4.5.12) of this chapter, before sending it back to the higher levels on/off site.

By this, the feedback facility will involve the whole construction organization and any construction personnel who is on/off site can

obtain figured reports on any operation on-site with the comments of the personnel who were in charge of carrying out that operation.

Chapter ten explains this facility and describes how the system could achieve an integrated feedback through the construction organization both on and off site.

The flow chart of "PLUS COST" in figure (4.4) shows the system's "Main Menu" option with the data which can be obtained from these options through the system and then shows how this data will be used by the system to produce the output controlling and feedback reports.

4.6) THE GENERAL FEATURES OF "PLUS COST"

In addition to the previous controlling and integration function, the following are the general features of "PLUS COST", on which I have developed the system to increase the efficiency of achieving these control functions to improve the use of computers on site. These general features were identified as a result of my research survey (as explained in chapters two and three). The features are:

- 1) The coding system used for Bill Items is CESMM for civil engineering and SMM6/7 for building contracts which are the same ones used in INTEREST (ref.55), PLUS CASH (ref.79), TIANAREBA (ref.80) and PLUS VAL (ref. 75) systems (these systems will be used to access the data

to "PLUS COST" as explained in chapter five), for the reason of standardization for integration between the construction management systems. Also because the CESMM as it stands is a practical proposal that allows consistent coding of input within and between contracts, and the same can be said about SMM6/7.

- 2) The system uses cost center as standards for controlling and monitoring costs and values. These cost centers can be activities, trades or any type of grouping which is used to group the bill items in the other systems, so that the data accessed would be used in "PLUS COST" in the same groups as the cost center
- 3) The resources will be given numbers for each, at the beginning, and when they come again through entering the site data it will only require the number of the resource to be entered.
- 4) To overcome the complexity in using computer software, I have developed " PLUS COST" to be a command-driven interactive system which presents the user with the menu of options at every stage. This provides flexibility, in which the user can proceed through the system in his own sequence and at his own pace. It provides prompts and guidance to the user.
- 5) Also to make the system easy to use, I have developed it to prompt the user to answer the questions which are shown on the visual display unit (VDU) each time by the required site data which is the same as if he is filling in site sheets used by the manual system.

- 6) The system has a facility to show the question again on VDU and ignore any data typed in by the user as an answer, if the system found it not logical to be accepted before going to next question.
- 7) In addition to that, "PLUS COST" has the facility to give a chance to the user to amend the entered data or get out of the system before filing it by giving a list of three options (to amend, to file or to exit) after each time the data is typed into the system.
- 8) Through "PLUS COST", there is no need for the data to be entered twice at any stage, because the system is developed to store the data which are entered for the first time in data files to be used through the system whenever required automatically and that reduces the duplication and the calculation that is common at site level.
- 9) To make the system for both Civil Engineering and Building contracts as general as possible, I have developed "PLUS COST" as a set of subroutines, so that the system can be easily modified to suit the conditions of the site it is applied to.
- 10) The reporting system I have developed will provide two types of reports through "PLUS COST", one as quick on-screen view reports with each option of the system, and the other as print out reports through "Preparing Reports" option.
- 11) The line of analysis of reconciliation reports is optional, with up to six breakdown figures (labour, plant, material,

subcontractor, preliminary and profit/overheads).

4.7) USING "PLUS COST" ON SITE

To use "PLUS COST" for controlling the construction site efficiently, a terminalized system is preferred, in which a set of terminals one for each site of the project may be used to access the data from the site which is entered through a microcomputer and VDU to the Main Frame at the Main Office through these terminals as shown in figure (4.5.)

This terminalized system may have a sub-system on the site, so that the controlling reports with the comments on them from the personnel in charge of the site to the higher on-site personnel can be accessed whenever required. The system can also be connected to the off site main office departments to interchange the data between the site and the Main Office departments.

By having such a system the data can be accessed from Estimating , Planning and Quantity Surveying departments at the Main Office to the site, and then the actual costs and values will be sent back to these departments as figures or graphical reports from the site to update their estimates and plans.

However, the flow of data in and out of the system and the involvement of the construction organization on and off site in providing this data is shown in figure (4.6).

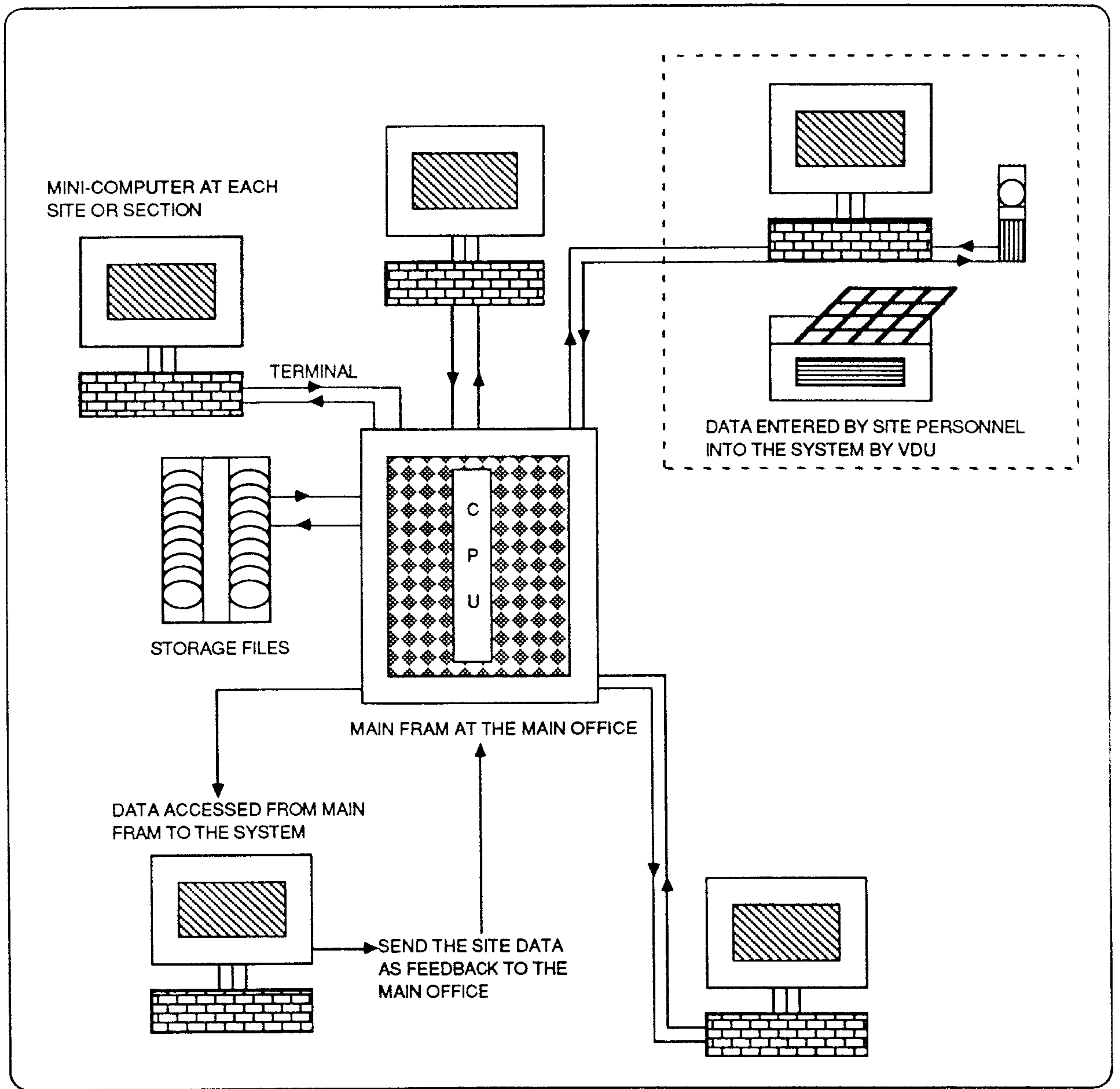


FIGURE (4.5); ON-SITE "PLUS COST" SYSTEM LINKED TO THE OTHER MANAGEMENT SYSTEMS AT THE MAIN OFFICE THROUGH TERMINALS

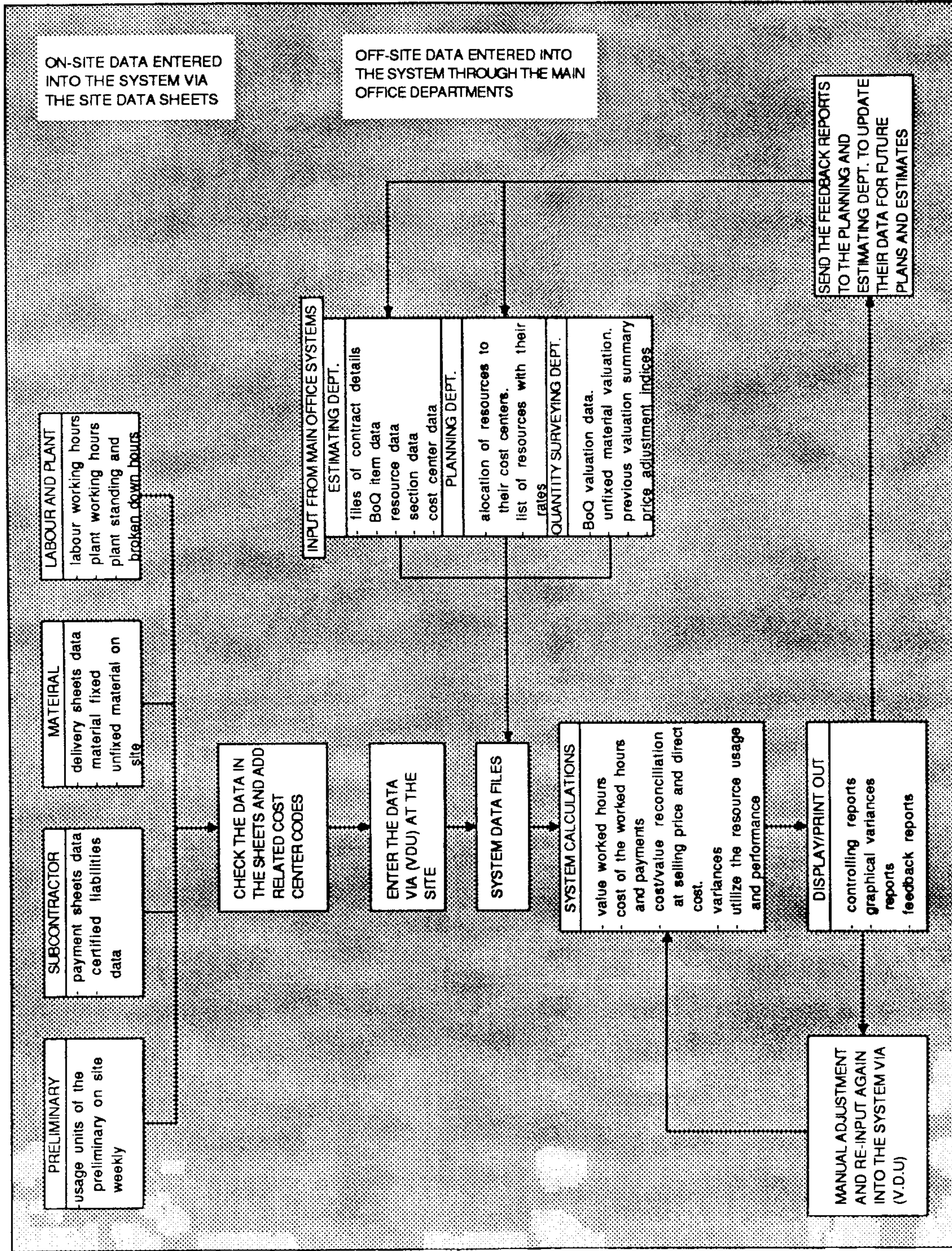
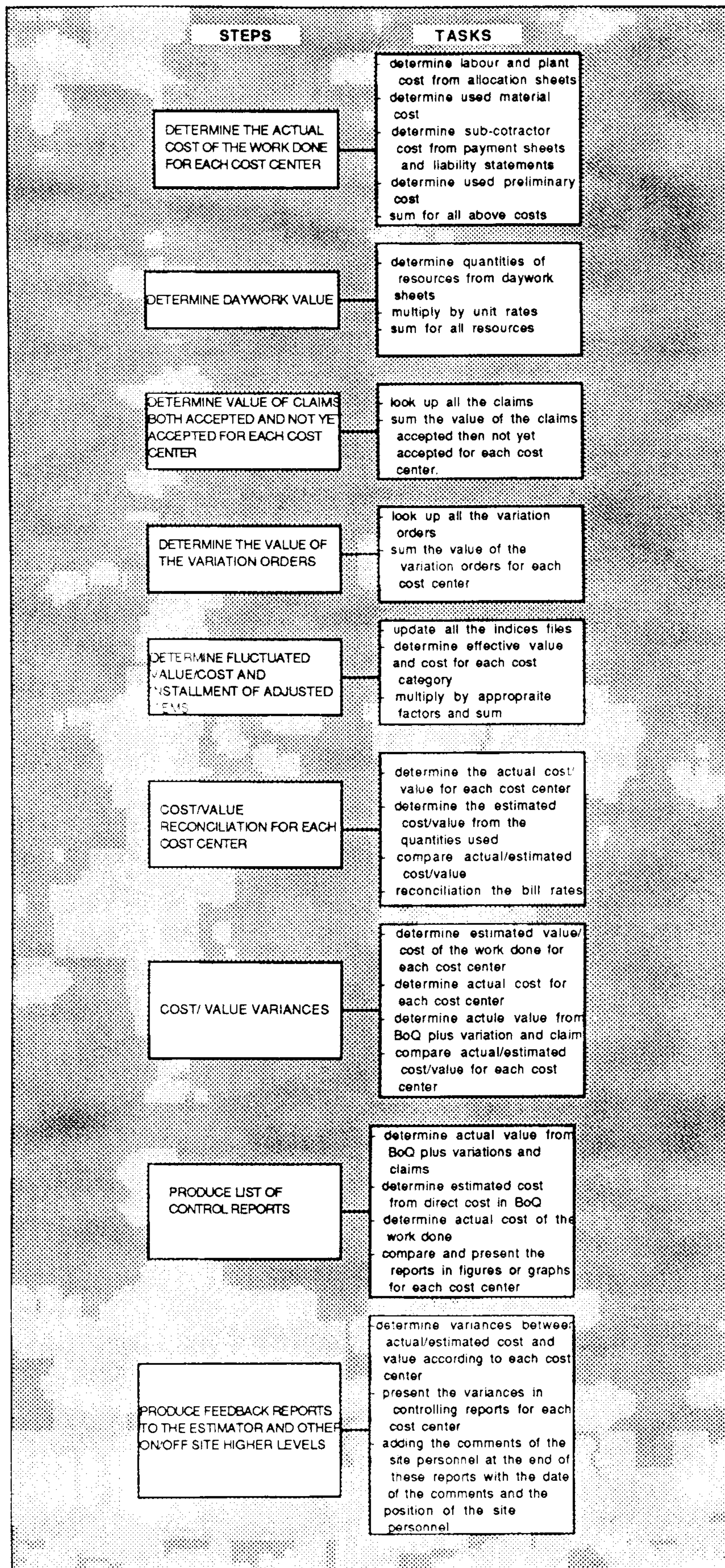


FIGURE (4.6); THE DATA FLOW INTO "PLUS COST" AS ON-SITE COST AND CONTROL SYSTEM

4.8) THE COSTING AND SITE CONTROL PROCEDURES IN "PLUS COST"

The steps and the tasks that "PLUS COST" is carrying out in site costing and controlling procedure is illustrated in figure (4.7). They are to:

- determine the actual cost of the work done for each cost center, by determine the following:
 - * Labour cost which includes; labour wages, bonuses, and on-cost overheads.
 - * Plant cost which includes; plant hire cost, non-operational cost and any extra costs.
 - * Material cost includes; cost of fixed material and wasted material.
 - * Subcontractor's costs includes; subcontractor payments, claims, variation orders.
 - * Preliminary costs includes; all the site costs other than those mentioned above, both preliminary in-rate and preliminary items.
- determine the value of work done as daywork by;
 - * Determining quantities of each resource used from daywork sheets;
 - * Multiplying by unit rate;
 - * Summing up all resources.
- determine the value of claims both accepted and not yet accepted by:
 - * Looking up all the claims;



FIGURE(4.7); THE STEPS OF THE SITE COST AND CONTROL PROCEDURE IN "PLUS COST" WITH THE TASKS INVOLVED

- * Summing up the value of claims accepted and those not yet accepted separately.
- determine the value of variation orders by:
 - * Looking up all the variation orders;
 - * Summing up the value of variation orders for each cost center.
- determine the fluctuated value and installment of adjustment items by:
 - * Updating all the indices files;
 - * Determining effective value and cost for each category;
 - * Multiplying by appropriate factors and summing up.
- reconcile the cost/value at direct cost or selling price rates by:
 - * Determining the actual cost /value for each cost center according to the breakdown figures;
 - * Determining the estimated cost/value for each cost center according to the breakdown figures;
 - * comparing the actual/estimated cost/value of the work done for each cost center;
 - * reconciling of the bill rates for future work.
- determine the cost / value variances by:
 - * Determining the total estimated value/cost of the work executed for each cost center;

- * Determining the total actual value/cost of the work executed for each cost center;
- * comparing the actual/estimated value/cost at each cost center.

_ produce a list of output control reports by:

- * Determining the actual value of the work done from BoQ, plus variation orders, claims accepted and inflation, and that for each cost center;
- * Determining the estimated cost of the work done using BoQ direct cost for each cost center;
- * Determining the actual cost of the work done for each cost center from site costs and payments to subcontractors;
- * Determining the comparisons and presenting them in reports for each cost center in figures or as graphs.

_ produce feedback output reports by:

- * Determining the variances between the actual/estimated cost and value according to the breakdown figures of each cost center;
- * Presenting the variances in controlling reports according to the breakdown figures of each cost center;
- * Adding the comments of the site personnel at the end of these reports with the date of

the comments and the position of the site personnel.

4.9) SUMMARY AND CONCLUSION

The following points are the summary and conclusion of the work I have done through this chapter:

- 1 - In this chapter, I have developed an integrated computer-aided site management model called "PLUS COST" (site management PLUS COSTing) to achieve the construction industry requirements "Business Requirements" specification as a result of my survey on the adequacy of the available site management systems as the first main objective of the research.
- 2 - Through "PLUS COST" I have also achieved the other two objectives in an integrated site management software. Firstly using a computer-aided system to assist an integrated site management system linked to the other construction management systems. Secondly reaching an integrated use of the site controlling results by sending them as feedback to the Main Office.
- 3 - Considering these objectives as well as the "Business Requirements" specification, I have developed "PLUS COST" to work under four headings. Under these headings, the site integration and control functions are developed.
- 4- These functions of "PLUS COST" , are :
 - * adjusting the actual value/cost of the

contract from the site practices:

- * cost accounting and performance control for labour and plant;
- * managing the material purchasing usage and utilization on site.
- * preliminary control on site;
- * cost and control of subcontractors on site;
- * feedback facility to the estimator and other higher personnel on/off the site;
- * a documentary system for controlling and valuing the site practices such as; claims and variation orders, etc.

5 - In addition to the above integration and control functions, "PLUS COST" has also a set of facilities, through which I have made " PLUS COST" a system which is easy to use, and efficient in achieving the functions which are summarized in the following points:

- a) The coding system used in PLUS COST is the one used in CESMM and SMM6/7 for Civil Engineering and Building contracts respectively for the standardization of being integrated to the estimating, planning and valuation and measurement software, which use these systems of coding. PLUS COST using cost centers as standards for controlling costs on site;
- b) "PLUS COST" has the facility to amend or edit any entered data through different

- ways, either by choosing "to amend" option after entering a group of data, or the system itself re-shows the question again on the screen if the answer was not logical;
- c) I have developed "PLUS COST" to work as a command-driven interactive system which presents the user with a menu of options at every stage. Through these options, the system will prompt the user to enter site data similar to that to be filled in site sheets.
 - d) The other facility of "PLUS COST", is "no duplication in data entry" through the system by filing the data which is entered the first time to be used whenever required again;
 - e) "PLUS COST" internal structure is in a set of subroutines, to make modifying the system to suit the required site conditions much easier.
 - f) Using "PLUS COST" on site can be very efficient by using terminals linking the site to the Main Office, so that the data entered from the site by using microcomputer, at each site or section is then accessed to the Main Office through the terminals;

6 - By using PLUS COST, a better controlling system has been achieved by having a better communication and data

accessing system between the Main Office departments and the on-site organization and between the different levels of on-site personnel themselves.

- 7 - Using PLUS COST on site instead of the manual system for controlling the site will reduce the number of staff required by using only one or two persons to feed the system. It will also save the time required for collecting the site data and doing the calculation and the paper work used on site.
- 8 - Once the data is entered into PLUS COST from the site, it will be immediately accessed to the Main Office and the costing and controlling reports will be produced in less than 5 minutes. It used to take about 15 days to get the reports ready in the manual system, because of the time required for collecting the data, accessing it to the accounting department and then calculating the cost.
- 9 - PLUS COST saves a lot of the clerical work such as filling in sheets, doing calculations, documenting the files and then issuing payment sheets.

From reading this chapter, it can be observed that in developing "PLUS COST", I have achieved the requirements of the construction industry which leads to an integrated and efficient site management, by having a list of integration and control functions in the system. Through each of these functions, "PLUS COST" has achieved part of these requirements (as explained in the following chapters), and by having all these functions at the same time through the system structure, the research objectives of

using computer-aided construction management to assist in achieving the required integration and efficiency in the site management have been fulfilled.

CHAPTER FIVE

CHAPTER FIVE

INTERFACE BETWEEN SITE MANAGEMENT AND OTHER MANAGEMENT SYSTEMS

5.1) INTRODUCTION

In the majority of cases, existing management software are independent systems in the sense that they do not share common data files or pass data amongst themselves (ref. 70), this has been identified from my survey on current site control software available in the market (as explained in chapter three). This lack of integration is as surprising as it is undesirable, considering the inter-related nature of the individual functions they support. For instance, the construction programme of a project has a great influence on the estimate of cost as well as its cashflow forecast, whilst the basis of any site control must be the figures which are prepared by the estimator before submitting the tender (ref. 71). On the other hand, through an integrated construction management system, the site control system could provide feed-back to the estimator who will be responsible for pricing more competitive tenders in the future.

In chapter four, I explained the achievement of one of the objectives of the research by developing a software model called "PLUS COST" which expected to achieve the "Business Requirements" specification of an efficient site management

system. This chapter explains the achievement of another objective by examining the feasibility of an integrated site management system linked to the other construction management systems of: Estimating, Planning, Cashflow Forecasting and Valuation. The chapter also explains how "PLUS COST" could achieve this objective by being an integrated site management system as well as self-contained (stand-alone).

This chapter has been divided into three parts. The first part explains the construction organization and its functions. It also identifies the flow of the management information through each function. The second part concentrates on the site management function because this is the function covered by "PLUS COST". Through this part, details of the management data required for the site management from the other functions are given and the contribution of each function in providing part of this data is shown. At the end I have identified the "Data Requirements" of an integrated site management system linked to the other management functions. In the last part of the chapter, I explain how "PLUS COST" can achieve these requirements to justify the system being an integrated site management system linked to the other management systems as well as being self-contained. An integrated computer-aided construction management software developed at the Civil Engineering Department of Loughborough University have been selected to be used in examining the integration of PLUS COST. Each piece of the software can achieve one of the management functions of Estimating, Planning, Cashflow Forecasting and Valuation. The software has been

examined to identify the management data that can be provided from their data files comparing with the "Data Requirements" of an integrated site management system. This part then explains how I have developed "PLUS COST" to achieve the required data integration by accepting the management data from these software data files through the system to use it in its site management functions. At the end I explain the self-contained facility in "PLUS COST" to be used in case no such management software are available for accessing the data.

The conclusion of this chapter achieves another main and important objective of my research which is; " to examine the feasibility of an integrated site management system linked to the other management systems and to produce the "Data Requirements" for such an integrated computer-aided site management system. This chapter also achieves the objective of developing an integrated computer-aided site management system linking to Estimating, Planning, Cashflow Forecasting and Valuation systems.

5.2) FLOW OF INFORMATION THROUGH THE MANAGEMENT FUNCTIONS

There is a wide range of variation in organization structures amongst construction companies. The most common organization of the contractor's management functions are (ref. 70):

- Estimating;
- Planning;

- Cashflow Forecasting;
- Valuation;
- Accounting and Cost Control

The reasons for these particular functions are, firstly that they are easily identified as the basic building blocks of any organization and, secondly, that there is a general tendency to list commercially available software under those functions (ref.70). All the construction companies, I surveyed, have the same structure for their organization.

Before examining the feasibility of an integrated site management function linked to the other functions, this first part of the chapter reviews briefly each of the above construction management functions with its management information which can be used for site management.

This review gives a complete picture of "Data Provision" of the other construction management functions to the site management function through an integrated construction management system. I have used the review, later in this chapter, in identifying the "Data Requirements" of an integrated site management.

5.2.1) Estimating

Estimating is defined by the Institution of Civil Engineers (72) as the task of determining the right price for the contract BoQ item rates, at which the contractors can carry out the contract.

During estimating, the contractor is subject to two opposing pressures. On one hand his price should be so low that he will win the contract against his competitors. On the other hand, his price should be so high that he makes an acceptable level of profit on it.

By following certain steps in producing an estimate of civil engineering works as described by McCaffer and Baldwin (73) and Ndekugri (75) or building work as described by Seeley (74), the following information is produced:

* For Civil Engineering Work (ref. 75):

- BoQ;
- Analysis of the BoQ;
- Contract dayworks schedules;
- Take-off data;
- Preliminaries budget;
- Resources reconciliation;
- Corporate resources costs data;
- Contract resources costs data;
- Schedule of average rates;
- Unit/Standard costs;
- Labour, plant and material output rates;
- Budgeted profit and loss account;
- Budgeted balance sheet.

* For Building work (ref. 76):

- BoQ;
- BoQ build-ups;
- Analysis of daywork schedules;

- Unit/Standard costs;
- Labour, plant and material output rates;
- Material usage and wastage rates;
- Budgeted profit and loss account.

If such estimating steps have been followed and the above information provided at the estimating stages as well as the estimates, such an estimating system will be quite effective in providing data for both types of contracts (civil engineering and building). This data will be used later in monitoring and controlling the performance of labour and plant as well as the material usage on site by comparing such estimated output and usage figures against the actual. The information listed above must, by necessity, be provided by an estimating system in addition to the basic estimate.

5.2.2) Planning

The term planning as used in the construction industry appears to mean different things to different people. Pilcher (74) defines it as; "the drawing up of construction programmes", also Cooke (77) suggests that the procedure involved in planning may vary from company to company. The definition I adopted in this research is that of Moder (78), who defines planning as; "the process of preparing for the commitment of resources in the most economical fashion".

A literature survey by Ndekugri (75) summarized the procedures of planning which once they have been achieved successfully,

produce the following information:

- The Master Program;
- A Schedule of Labour Requirements;
- A Schedule of Material's Requirements;
- A Schedule of Sub-Contractors and Suppliers;
- A Schedule of Information Required from Consultants;
- A Schedule of Activities and their Resources and Requirements;
- A Schedule of Resource Constraints, Resource Type and Description.

The above list of planning information is ideal for any efficient planning system and may be used to plan and schedule the work in any construction project. This information of scheduling the project resources to their activities/cost centers will simplify the way of controlling such resources later on site by using the same cost centers to calculate and control the actual cost/value against the planned figures.

5.2.3) Cashflow Forecasting

The relationship between the cost liabilities incurred by the contractor and the money coming into the company is usually classed as cashflow, which is defined by Harris and McCaffer (6) as; "the transfer of money into and out of the company".

Cashflow forecasting involves certain basic tasks to be carried out for each project on-going or expected to be won. These tasks

are described by McCaffer and Baldwin (73), Harris and McCaffer (6) and Cook and Jepson (8). From these cashflow forecasting tasks above, the following information is produced (ref. 75):

- Project Cashflow;
- Corporate Cashflow;
- Project Financing Costs;
- Corporate Financing Costs.

In addition to that we can gain information on (ref. 13):

- allocation of items from BoQ to bars on a bar chart;
- allocation of items from BoQ to activities / trades.

Money is the main objective of any cashflow forecasting system which is aiming to control the flow of the money into and out of the company from the construction projects. Such forecasts are required to be compared against the actual cashflow to make the idea work from such a system. From the above information, I believe that if such information could be obtained from a cashflow system, the method of controlling the flow of the company cash will be more efficient. Allocating the items to their activities/cost centers will simplify allocating the actual cost/actual cashflow figure on site and making the comparison between the forecasted figures and the actual according to the same cost center more effective.

5.2.4) Valuation

The valuation is defined by Wager (49) as; "the measurement of the value of the work done on the contract", but

one can identify immediately two forms of that action, internal and external valuation. The internal valuation is the work of the contractor's surveyors, and represents the (internal) value of the work done to date, which will be reconciled with the costs of construction for the same period. The external valuation is that measure to be agreed with the client's surveyor known as the Professional Quantity Surveyor [PQS] (ref. 49).

This research deals with the internal valuation which shows exactly the value of the work done, while the external valuation shows the value of the work done from the clients point of view, which is usually less than the actual value of the work done.

The processes and procedures involved in the valuation functions are described by Ndekugri (75). From these valuation and measurement procedures, the following information is produced:

- interim payment certifications;
- statement of retention and of subcontractors values;
- dimension sheets covering any measurements;
- listings of quantities and values of items done at the end of any valuation;
- daywork account summaries;
- listings of claims accounts;
- unfixed material accounts;
- variation orders accounts.

Such information will be very useful for the site control system to calculate the actual value of the work done in the cost/value

reconciliation. The data about measurements (internal measurements) will be used to calculate the estimated cost of the work done to be compared against the actual. The information about the unfixed material on site can be used for controlling the utilization and wastage of the material on site at interim periods. Such a valuation system can provide data on the site practices such as: dayworks, claims, variation orders and price adjustment and it can be very beneficial to use such data for adjusting the site figures according to these practices to make the control figures more accurate and more efficient in controlling the construction site.

5.2.5) Cost Control and Monitoring

The nature and role of cost control and monitoring (site control) is described in the first part of chapter two. Valuation which provides the standards of performance as well as the accomplishments of the work items as explained previously is described in detail by Ndekugri (75). Thus, though valuation is a management function of its own, it is also viewed as one of two sub-divisions of the site control function (Cost Control and Monitoring), with costing as the other sub-division and data can be gained from the site control system which is explained in chapter eleven.

5.2.6) Cost Accounting

Description of the processes and procedures involved in costing as well as the way of producing the information required for the control of the various resources are

explained in the following chapters:

* Labour, Plant, Material	chapter 6
* Sub-contractors	chapter 7
* Preliminaries	chapter 8

The information which is produced from costing is:

- labour costs of work items from the unit cost of labour and time sheets;
- equipment costs of work items from unit cost of plant and equipment time sheets;
- subcontractors cost by reference to either subcontractors' invoices or valuation of subcontracted work on the basis of the appropriate subcontract;
- material costs from delivery sheets as well as unfixed material on site;
- preliminary costs of the work items as well as preliminary bill items;
- the manipulation of cost data to provide costs of work items, activities / cost centers, or the entire contract.

The costing information and valuation will be used to produce the site control information which is described in chapter eleven:

- Cost / Value Reconciliations;
- Labour and Plant Actual Output Rates;
- Labour and Plant Actual costs;
- Material Usage and Utilization Reports;
- Preliminary Usage Reports;

- Analysis Variances;
- Activity / Cost Center Items List;
- Short Term Planning Reports;
- Cost Statements;
- Feedback Reports to the Estimator and Planner.

Although the two sub-systems, (valuation and costing) are essential to achieve the site control as explained above, the other construction management functions are also essential and required in providing an integrated and more efficient site control because these functions can provide important data for controlling the site and could save a lot of time and work in providing such data for the site control function. The contribution of the construction management functions in providing the data for an integrated site management and control system is described in the following review of this chapter.

5.3) ESTABLISHING DATA FOR THE SITE CONTROL SYSTEMS

In the first part of the review, I explained the construction management functions, the information provided by each function and then how this information can be used by the site management function. The review also explained the site management (control and monitoring) function and its required management data.

This second part of the chapter is using the data provided from the above review to identify the "Data Requirements" of an integrated

site management function from the other management functions, and the role of these functions in providing these requirements (as explained in the previous review).

This review will detail the integrated flow of information into the site management function from the other management functions in the integrated construction management system. From this review I identified the basis of an integrated construction management system, on which I have depended in selecting the integrated construction management software and examined the feasibility of "PLUS COST" as an integrated computer-aided system linked to the other management systems.

However, from the previous review I identified the following list of data required for the site management (control and monitoring) function:

- general contract information;
- sub-contractor's information;
- supplier's information;
- supply information (orders and deliveries);
- methods of measurements;
- bill of quantities build-ups;
- bill of quantities data;
- analysis of bill of quantities;
- bill of activities / cost centers;
- cost centers price breakdown;
- variations and claims data;
- labour, plant output rates;

- material usage and wastage data;
- unit / standard costs;
- measurements of work done;
- preliminaries calculations;
- labour and plant time / task sheets;
- daywork sheets;
- unfixed material inventories;
- subcontractor's payments.

As explained in the previous review, each management function is required to provide part of this list through its management operation. The data is then gathered through the site management function to produce the required control reports.

The following reviews the role of each management function in providing part of this list of the required data.

5.3.1) Estimating Function

From the estimating function, the following data can be provided:

- general contract information;
- bill of quantities data;
- bill of activities / cost center;
- bill of quantities build-ups;
- contract resources list;
- allocation of bill items to categories.

5.3.2) Planning Function

From the planning function, the following data can be provided, some of the data can be provided by other functions as well:

- lists of resources and their requirements for each cost center/activity;
- lists of cost centers/ activity;
- progress reports of resources usage.
- lists of resource constraints, types and descriptions.

5.3.3) Cashflow Forecasting Function

This function will provide the following data for the site control function as well as the other management systems:

- budgeted cost data;
- programmed resource usage (aggregation) data;
- budgeted payments receipted and value of work internally;
- predicted cash flow data (outflow, inflow, netflow and interest).

5.3.4) Valuation and Measurement Function

Through this function, the data that can be provided for site control is:

- bill of quantity valuation data;
- variation calculations data;
- claims calculations data;
- daywork data;
- unfixed material valuation data;

- previous valuation data;
- unfixed material data;
- material deliveries;
- purchase orders;
- fluctuation indices data.

5.3.5) Cost Accounting Function

The remaining data required to be provided for site control can be gained through this function of management, this data is:

- labour and plant output rates;
- material usage data;
- material wastage data;
- preliminary usage data;
- labour and plant time/task sheets;
- cost statements;
- sub-contractors payments data;
- on-cost payments data.

5.4) LINKING OF SITE COST AND CONTROL SYSTEM TO THE OTHER MANAGEMENT SYSTEMS

In this third part of the chapter, I have depended on the previous review to examine the feasibility of "PLUS COST" as an integrated site management system linked to the other management systems. I have selected a various integrated computer-aided management software, and compared the data that can be provided by each piece of the software with

the role of its function in providing the required data for the site management (as explained in the previous review). All the required data from each management function must be provided through its software. Also the software must be integrated and have the same computing language of "PLUS COST". This part describes the selection of the software and their data files from which the data can be accessed when it is required through "PLUS COST". Finally this part explains the development of "PLUS COST" to be a self-contained software by entering this required data manually in case no such software is available to be linked to "PLUS COST".

The selected software was provided from a research team at Loughborough University of Technology, Civil Engineering Department who had started to understand the problem of integrated construction management systems by developing a computer-aided estimating system called INTEREST. This system not only meets the requirements of most estimators, but also makes provision for total integration of contract information (ref. 81). Sub-systems for computer-aided cashflow forecasting named CAFALARR and now called PLUS CASH (to indicate INTEREST, plus cashflow) (ref. 79), and computer-aided time analysis and resources balancing (TIANAREBA) (ref. 80), had also been developed to be linked to INTEREST. Later, a computer aided valuation system had been developed to be linked to INTEREST named "PLUS VAL" (ref. 62), and for the reasons of integration, I have developed a computer-aided costing and site control system called "PLUS COST", to be linked to the "INTEREST, PLUS CASH,

TIANAREBA and PLUS VAL" systems, so that the data can be accessed into "PLUS COST" for costing and controlling purposes, in return, the data can be accessed from "PLUS COST" as feedback to "INTEREST and TIANAREBA" as estimating and planning systems respectively.

The reasons behind selecting the above systems for examining the integration facility of "PLUS COST" comes from investigating these systems and their data files to check the data that can be accessed from these systems according to the management functions they can achieve. This data was matched with that required by "PLUS COST" for achieving the site management.

However, the following reviews this investigation and explains the mechanism of this integration in detail.

5.4.1) Computer-Aided Estimating System (INTER EST-CE and BUILD)

This estimating system "INTER EST-CE and BUILD" which had been developed for Civil Engineering and Building contracts contains the following group of files to support the estimator and record the results of his calculations (ref. 81);

- **Company Data Files:** contains the all-in cost of different categories of labour, different items of plant and materials prices.
- **Performance Data Files:** contains item build-ups with resources and usage rates for the commonly recurring items of work.

- **Contract Specific Data Files:** contains two types of files. The Direct Contract Data File; holding the direct cost of carrying out the work involved in the contract. The other file is the Selling Price Data File; holding the direct cost adding to it the percentages of profits/overheads and adjusting price.
- **Operational Resource Files;** contains the cost data relevant to the method which requires the estimator to base his work on the total amount of time that resources will be deployed for specific tasks.

At the completion of the direct estimate, the following data can be provided (ref. 81):

- a) bill listings for each bill item into labour, plant, material, auxiliary plant and subcontractors;
- b) direct cost summaries; direct cost totals for labour, plant, auxiliary plant, subcontractors for the whole bill, section, page and trade;
- c) resource reconciliations; lists of all the resources used in estimator build-ups and resource quantities (plant and labour hours, material quantities), cost of these resources;
- d) listing details and the quantities of material with the associated bill items;
- e) lists of the operational groups;
- f) listings of current contracts general information;
- g) un-priced bill items list;
- h) list of calculation procedures of identified items.

All the information required from the estimating system for the integrated site management can be provided by "INTEREST" system, also this system matches "PLUS COST" in its computer operating system and the computer language. I have selected this system to link it to "PLUS COST" and from that the required data can be accessed, as explained here under.

Linking to "PLUS COST" System

By linking "PLUS COST" to "INTEREST", "PLUS COST" will be able to share the following data with "INTEREST" Data Files by accessing this data into its data files to be used then in its costing and controlling procedures. This required data is usually stored in "INTEREST" data files and it is required from "PLUS COST" to call these files to be opened and to take the required data through its system structure. The data which can be provided by "INTEREST" is stored in "File of Contract Details", and "Contract Data Files" for both selling and direct prices as shown in figure (5.1). This required data is (ref. 81):

- Bill of quantity data;
- Bill items data;
- Resource data;
- Operational groups (activities /cost centers) data;
- Section data;
- Budgeted costs;
- Allocation of bill items to categories.

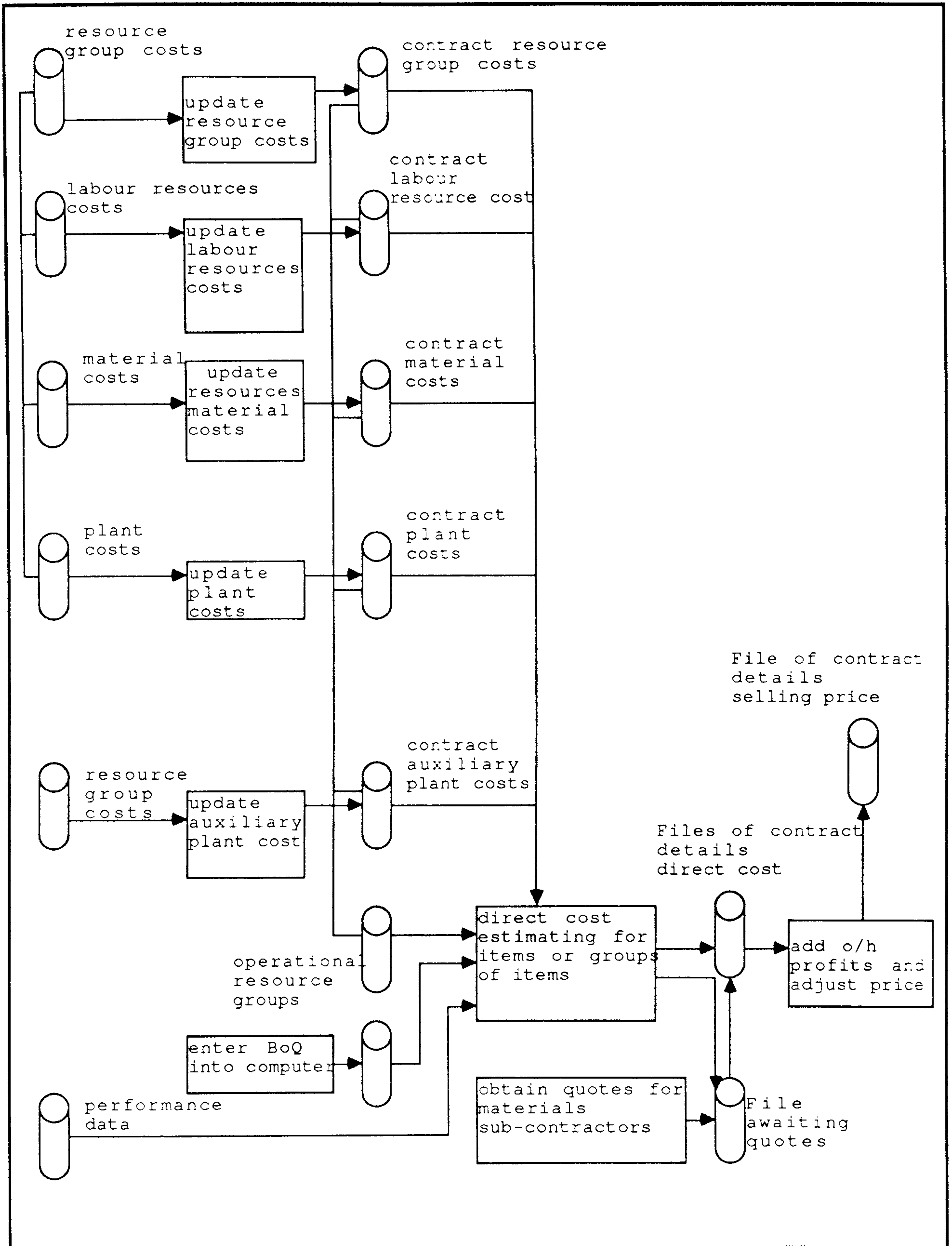


FIGURE (5.1); "INTER EST" FILE STRUCTURE

(© Baldwin 1980)

Figure (5.2) shows the accessing of INTEREST data files to the other systems (ref. 81).

5.4.2) Computer-Aided Planning (TIANAREBA)

This package had been developed to get the data accessed from "INTEREST SYS. 2" to achieve the following tasks (ref.80):

- a) item allocations;
- b) item analysis;
- c) resource balancing;
- d) resource constraints.

In this system, a CESMM classification is used in coding the items (i.e. section, page, item number (ref. 20)).

From the first task, the system can provide:

- Listings of item allocations and proportions for each activity/cost center;
- Listings of item allocations for all the activities.

The second task of the system is to allocate time for each activity as activity duration, successor and overlap, and from these the following reports can be provided:

- lists of successors and overlap for each activity;
- lists of all the activities with their durations.

The third task of the system is to allocate resource parameters to each activity of a construction programme, from which a list of

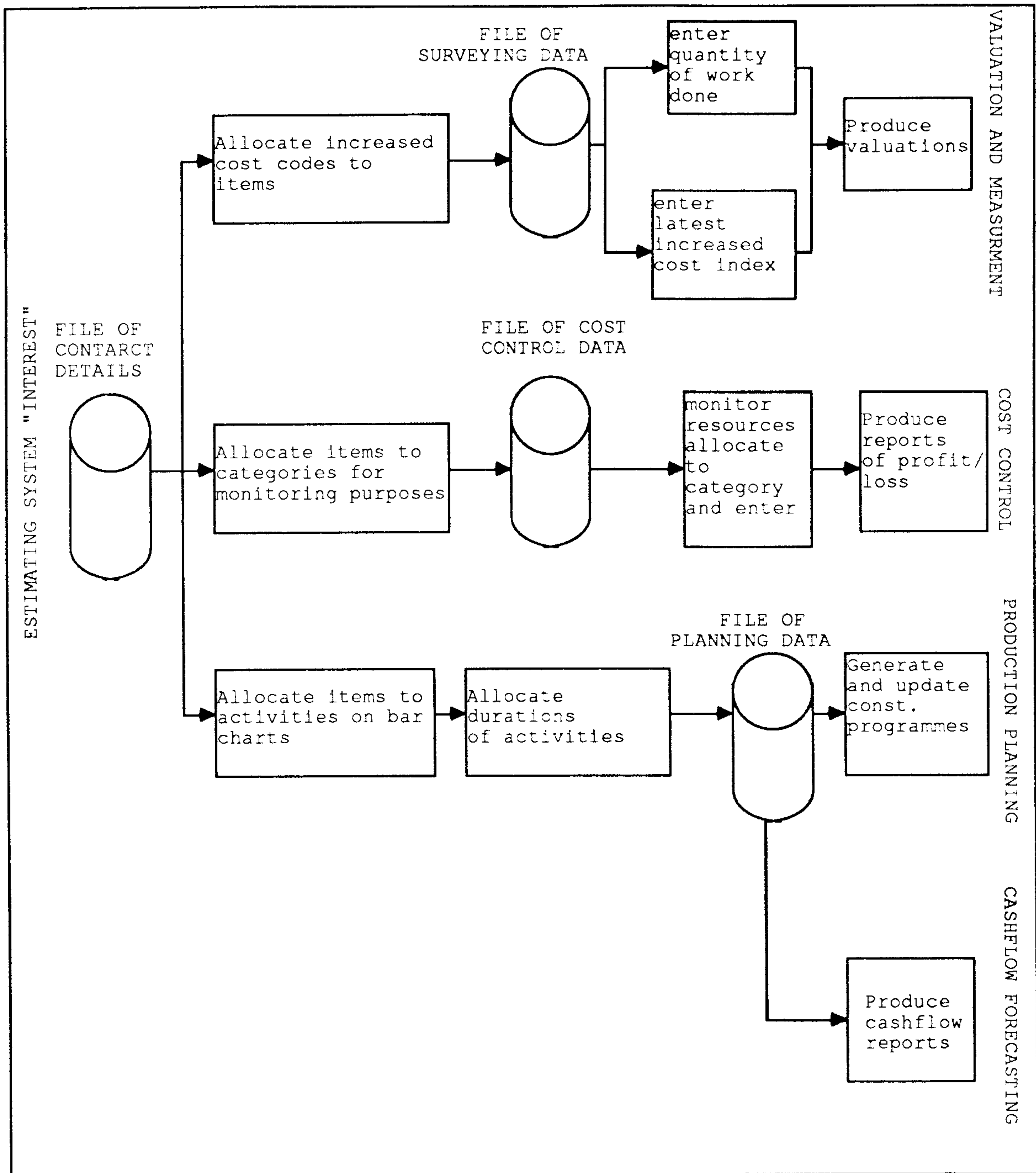


FIGURE (5.2); USING ESTIMATING SYSTEM "INTER EST" INFORMATION BY OTHER SYSTEMS

reports can be provided as follows:

- lists of all the activities and their resources and requirements with the description of the activities;
- lists of all the resources and their requirements for each activity;
- lists of all the resources with their schedule of uses, starts, finishes and levels.

Through the fourth task, the system allocates all the resource constraints by entering resource numbers, description and limiting levels. The system can then provide the following report:

- lists of resource constraints, resource types and descriptions.

From the above system tasks and the management data produced by these tasks, which covers the data requirements of "PLUS COST" from a planning system, (as explained before through the second part of this chapter), and because of both systems (PLUS COST and TIANAREBA) are written in the same computing language, the linking of these two systems is feasible, as explained in the following;

Linking to "PLUS COST" System

By linking "PLUS COST" to the " TIANAREBA" system, all the following required integration data for site control procedures can be provided from the Planning software "TIANAREBA" Data Files, this data is (ref. 80):

- Bill Item Data (from Item Allocation File);

- Activities Data (from Item Allocation File);
- Resources Data (from Time Analysis File);
- Bill Items Allocation to Their Categories (from Item Allocation File).

The above data can be accessed by calling its "Data Files", through "PLUS COST" while the site controlling calculations are carried out to produce the required reports together with the data from other construction management systems. The flow chart for the system is shown in figure (5.3), which shows the data that can be provided by "TIANAREBA" (ref. 80).

5.4.3) Computer-Aided Cashflow Forecasting (PLUS CASH)

This system was developed to produce contractor's cashflow and resource usage reports from tender estimates prepared by linking to "INTEREST- CE SYS 1" system. In this program the items in the BoQ are allocated in activities as on a bar chart with the provision of some additional information.

The calculations of cashflow will produce the following data (ref. 79):

- cost breakdown into labour, plant and material on a week by week basis;
- the resource requirements for selected resources on a week by week basis;
- payments, receipts and value of work, on a week by week basis;
- cashflow on a week by week basis.

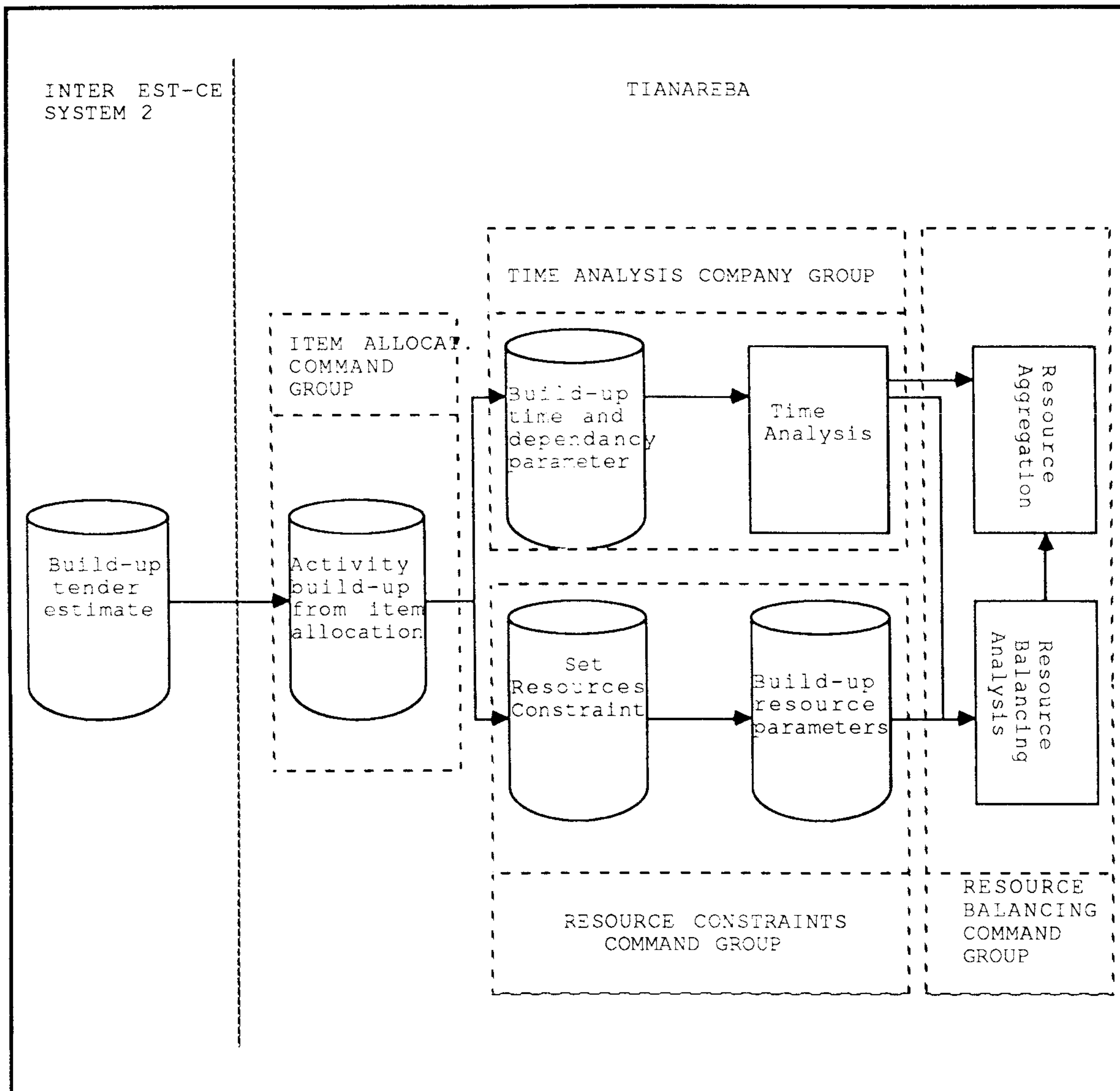


FIGURE (5.3); "TIANAREBA" FLOW CHART AS DATA GENERATED INTERNALLY BY "INTER EST- CE SYSTEM 2"

The above data was proved to match the data required to be provided by the cashflow forecasting function for "PLUS COST" as a site management function. "PLUS CASH" has also the same computing language as "PLUS COST", so that "PLUS COST" can be integrated to "PLUS CASH", through which the data files of "PLUS CASH" can be called by PLUS COST to access the required data for the site management calculations, as explained in the following;

Linking to "PLUS COST" System:

Having linked "PLUS COST" to "PLUS CASH", the following data will be taken by "PLUS COST" to be used as planned figures to be compared against the actual. This data is usually stored in the data files through "PLUS CASH" as mentioned hereunder. "PLUS COST" can call these files whenever it is necessary to get the required data for the site controlling calculations. The required data and their related files are:

- cost breakdown data as budgeted cost (from BARChart file);
- resource usage (aggregation) data (from EXP-INC file);
- budgeted payments, receipts and value of work data (from EXP-INC file).

The flow chart of the system is shown in figure (5.4). The figure shows the data provided by "PLUS CASH" (ref. 79).

5.4.4) Computer-Aided Valuation (PLUS VAL)

"PLUS VAL" was the latest attempt by the research team at Loughborough University to achieve an integrated

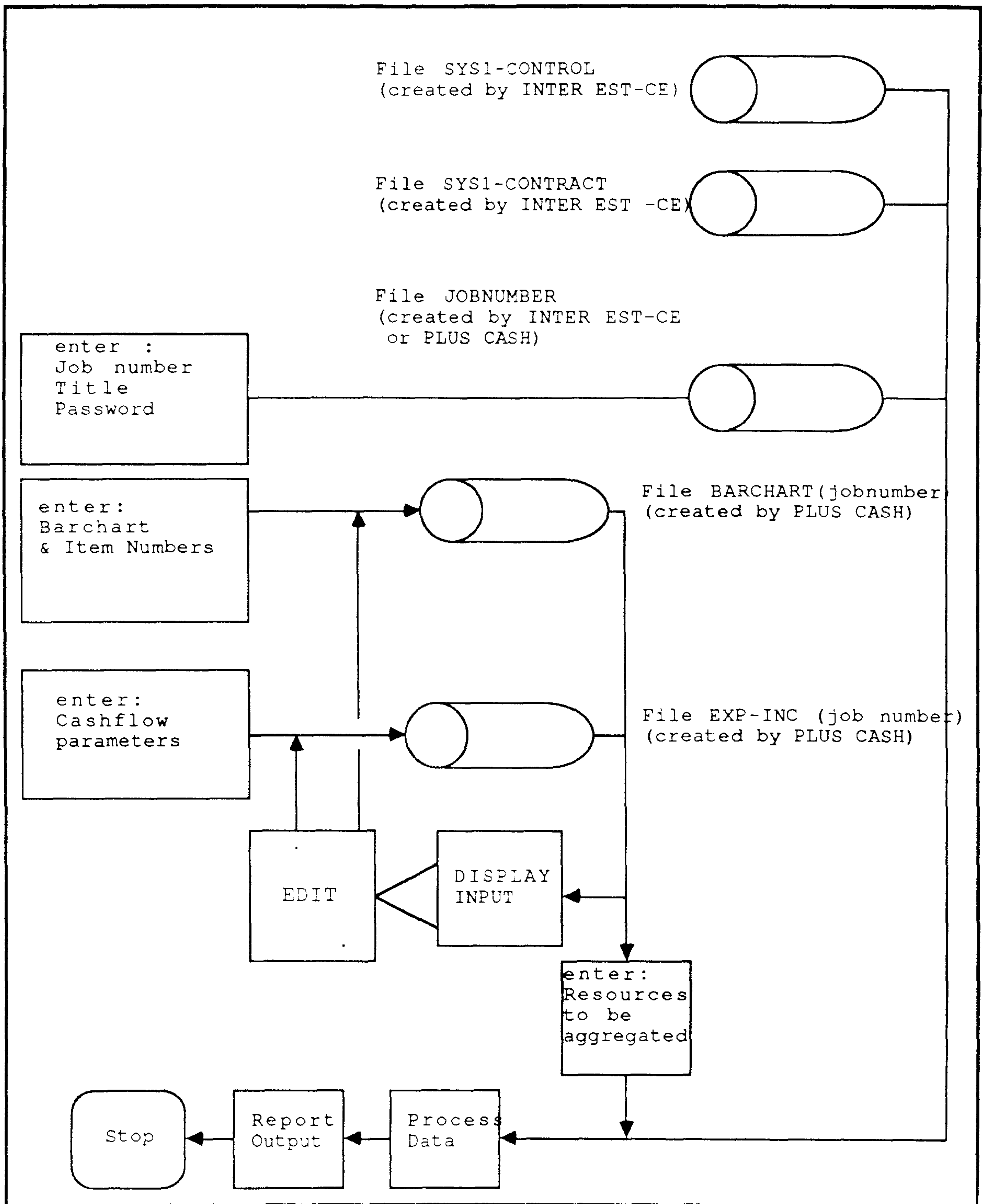


FIGURE (5.4); 'PLUS CASH' SYSTEM FILE STRUCTURE

management system which is claimed to be linked to "INTEREST". It is developed to carry out all the valuation, measurement and price adjustment calculations.

The main facilities of "PLUS VAL" are (ref. 62):

- measurement (bill items, daywork, unfixed materials);
- claims' register;
- price fluctuation calculations;
- installments of the adjustment item;
- valuation;
- file maintenance;
- reporting.

From these facilities, the following data will be provided:

- General Contract Data;
- Bill of Quantities Data;
- Unfixed Material Data;
- Daywork Resources Data;
- Claims Data;
- Variation Orders Data.

From the above list , "PLUS VAL" can provide all the required data as valuation function to "PLUS COST" as a site management system (as listed in the previous review). Also "PLUS VAL" has the same computing language of "PLUS COST". This makes the linking between the two systems feasible, as explained in the following.

Linking to "PLUS COST" System

From the above review, I have checked that "PLUS COST" can be integrated to "PLUS VAL", so that all the valuation and some other important management data for controlling the site can be provided from "PLUS VAL" by knowing the data files (which are shown in figure (5.5)) of this required data. The data files will be called by "PLUS COST" whenever required through its calculations as if they are its own data files. The required data which can be provided by "PLUS VAL" is (ref. 62):

- General Contract Data;
- BoQ Valuation Data;
- Daywork Data;
- Variation Orders Data;
- Unfixed Material Data;
- Claims Data;
- Price Adjustment Data.

At the end of this second review of examining "PLUS COST" integration facility, I have achieved the objective of examining the feasibility of having an integrated computer-aided site management system linked to the other construction management systems by using "PLUS COST". From this linkage, "PLUS COST" can benefit from the data produced and stored in the data files of the other management systems, by which it will save a lot of time and staff required to re-enter this data. Not just that, but "PLUS COST" can send back the controlling results through its data files to the estimating and planning systems as feedback data (as explained in

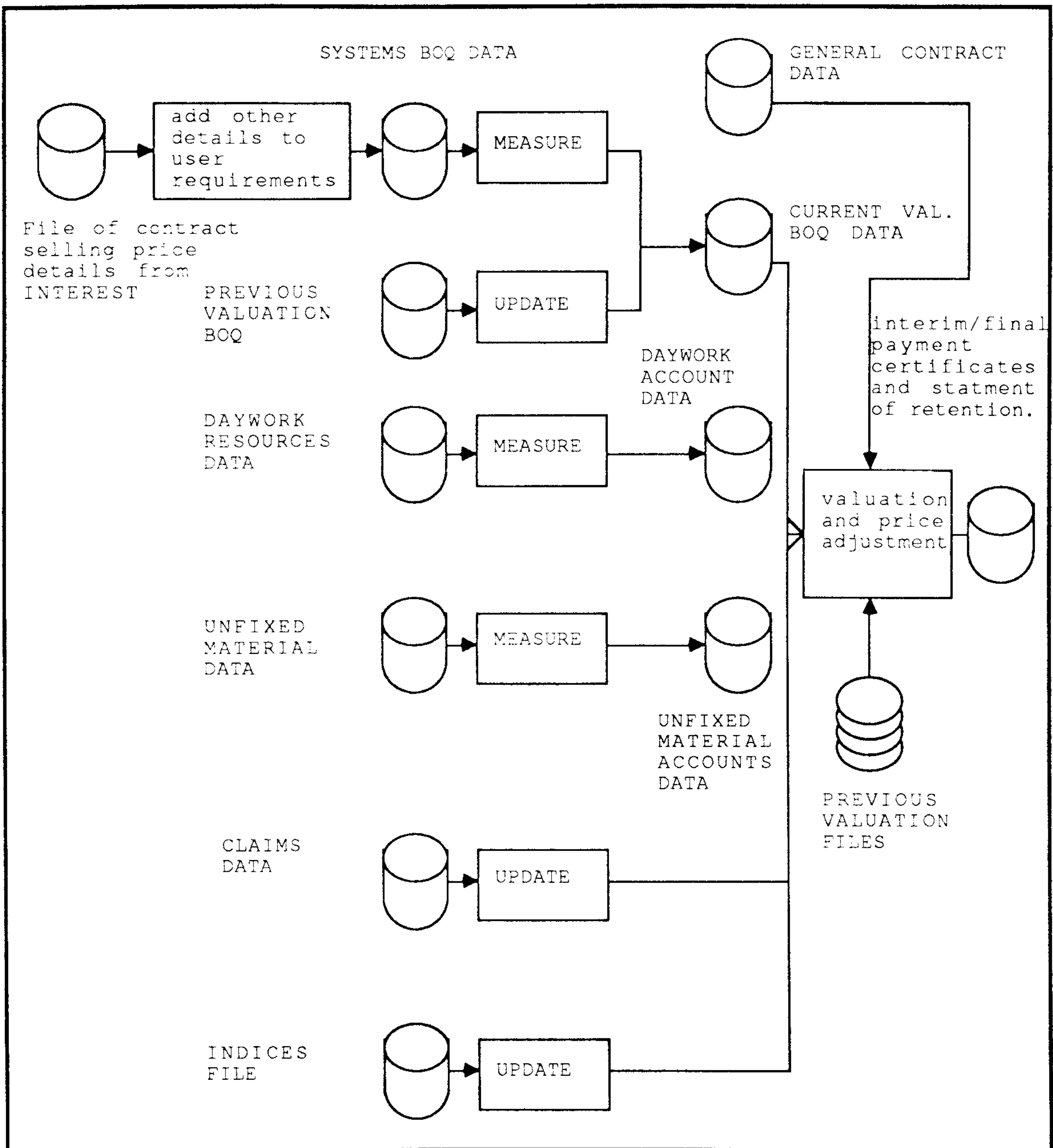


FIGURE (5.5); "PLUS VAL" SYSTEM FILE STRUCTURE

chapter ten). This will also provide a better and more integrated use of the site data.

The chart of information flow into "PLUS COST" from the integration to the other construction management systems mentioned above is shown in figure (5.6).

5.5) COMPUTER-AIDED DATA PREPARATION FOR COSTING AND SITE CONTROL SYSTEM

In the previous review of the third part of the chapter, I have explained how "PLUS COST" as a computer-aided site management system can be integrated to the other computer-aided construction management systems such as: estimating, planning, cashflow forecasting, and valuation. After that, I have examined the "PLUS COST" integration feature by using existing computer-aided construction management systems and linking them to "PLUS COST".

"PLUS COST" needs data from other construction management systems for its costing and site controlling procedures. This data is supposed to be accessed from the construction management systems when they are available and suitable to be linked to "PLUS COST". If such systems are not available for any reason, I have developed "PLUS COST" to be a self-contained (stand-alone) system in providing such data by manual entry.

This independence in "PLUS COST" in providing the required data

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can be achieved through "Data Preparation" option in the system, figure (5.7). In this option, all the data which is supposed to be accessed from the other systems can be entered manually and filed in the system data files before using its other controlling functions as explained in the following.

The data entry through those options must be used in the same sequence as listed in the system, to prevent data re-entry.

In the following, I explain briefly the data that can be entered manually through this function (Data Preparation) comparing with the data which is supposed to be accessed from the other systems.

If the user selects "Data Preparation" function, the system will take him to a list of options which includes:

- Bill Items Data;
- BoQ Valuation Data;
- Resources Data;
- Activities Data;
- Subcontractor's Data;
- Section Data;
- Unfixed Material Data;
- Engineer's Assessment for Price Adjustment.

These options will allow the user of "PLUS COST" to enter manually the required data for the costing and site control procedures through the system. This data is the same as the data that can be accessed from the other construction management

```
To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5
```

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

```
CONTRACT NO.:          1
PROJECT:              BALFOUR BEATTY CONSTRUCTION CRS SYSTEM
CLIENT:              BALFOUR BEATTY CONSTRUCTION CO.
                   55 MANSFIELD ST.
                   DERBY,
                   DERBYSHIRE,
                   UNITED KINGDOM
ARCHITECT/ENGINEER:  J. WALKER
                   57 BUCKINGHAM DRIVE
                   DERBY,
                   DERBYSHIRE,
                   UNITED KINGDOM.
TYPE OF THE WORK:    BUILD
```

=====
Press <CR> to go into the system.

***** Main Menu *****

Options:-

```
-----
Data Preparation -----1
Rouning Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14
```

FIGURE (5.7); SHOWS THE SYSTEM ENTRY WITH THE OPTIONS OF ITS "MAIN MENU"

systems. The following shows the data required to be entered through each of the above options comparing with the data to be accessed.

5.5.1) Bill Item Data

Through this option, the user has got to enter the following BoQ item data. This data is the same data as in "Contract Specific Data Files", both "Direct Cost and Selling Price" files of the estimating system "INTEREST".

The data for each item in the BoQ is:

- related bill page and section;
- item code, description, unit of measurement, quantity, rate and break down figures;
- item's subject to fluctuations.

After this data has been entered, "PLUS COST" will give a chance for the user to correct any human error in the data entered, before filing the data.

5.5.2) Bill of Quantity Valuation Data

This option prompts the user to enter manually the required valuation data which is supposed to be accessed from the BoQ Valuation File of "PLUS VAL" system (as explained before in this chapter).

The user has to enter only the change in the quantity executed for each item entered in the previous option. "PLUS COST" will

automatically bring the other required data from the previous option and calculate the value of the work done for each item and will show it on the screen as:

- Item Quantity;
- Unit of Measurement;
- Item Rate;
- Bill Amount;
- Previous Amount;
- Amount Now;
- Quantity to Date;
- Amount to Date;

with an option of any amendment in the entered data before being filed in the Valuation File of the system.

5.5.3) Resource Data

This option prompts the user to enter the required resource data which is supposed to be accessed from the "Resource Data File" in the planning system "TIANAREBA".

The system classifies the resources into labour, plant, material and the user has to enter the required data for each type of resource which will be used in executing the contract; this data is:

- Resource Number;
- Resource Description;
- Resource Unit of Measurement;
- Resource Rate per Unit;

The data will then appear after entering each resource to give a

chance for any mistakes to be corrected before being filed.

The system automatically updates this entered data as well as prompting the user to add any more resource whenever requested.

The resource's data will be used later through the system to calculate the cost of each operation by multiplying the quantity executed by the unit rates, as well as for cost/value reconciliations purposes as explained in chapters (six to ten).

5.5.4) Subcontractor Data

Through this option, the user has got to enter the subcontractor general data that is supposed to be accessed from the estimating package INTEREST if it is available, otherwise, the user selects this option and the system will then prompt him to enter the general data about the subcontractor which is; subcontractor number, name, payment and agreed rate per unit.

The system will then show the entered data on the screen for any amendment that may be required before being filed.

This data will then be used by the system automatically in calculating the actual cost of the work done by the subcontractors and their liabilities as explained in chapter seven.

5.5.5) Cost Center Data

The system uses cost centers for grouping the BoQ items in controlling the project cost and the resource performances by relating each BoQ item or project resource to one

of these cost centers. In the civil engineering work, the activities can be used as cost centers, while in building works, the trades can be used as cost centers. The user has the choice to use whatever method he wants for grouping the Bill Items as cost centers. The data about these cost centers will be entered manually if there is no access to the " Resource Data File" of the planning system " TIANAREBA". The data is:

- Cost Center Number;
- Activity Code (if it is not taken as a cost center);
- Cost Center Description;
- Cost Center Quantity;
- Cost Center Breakdown figure amounts to labour, plant, material, subcontractors, preliminaries and profit/overheads;

"PLUS COST" will depend on these cost centers in all the calculations and site control procedures.

Again, after all the cost center data is entered, "PLUS COST" will show it on the screen to give a chance for any amendment before being filed.

5.5.6) Section Data

This option prompts the user to enter the required BoQ section data which is supposed to be accessed from "BoQ Data File" in the estimating system "INTEREST" if available. This data is; bill section number, description and amount.

This data will appear on the screen for amendment, if any, otherwise, the data will be filed. This data will be used in producing the reports of BoQ listings as explained in chapter eleven.

5.5.7) Unfixed Material Data

This will prompt the user to enter all the data concerning unfixed material after each external valuation or interim payment.

The data here is similar to that which is supposed to be accessed from the "Unfixed Material Data File" in the valuation system PLUS VAL, if available. The data is:

- Valuation Number;
- Unfixed Material Resource Number;
- Quantities of Resources;
- Percentage to be paid for;
- Activity Number of The Resource;
- Section Number;

Again, the entered data will be shown on the screen for any amendment. This data will be used in controlling the material usage and utilization on site as explained in chapter six.

5.5.8) Engineer's Assessments for Price Adjustment

For the purpose of adjusting the values of the Civil Engineering contracts against the price fluctuations, the Consulting Engineer breaks down the contract value into fourteen

categories when preparing the tender documents. These categories will be used in the NEDO formula at each interim valuation to adjust the actual value which was calculated from the BoQ items rates (as explained in detail in chapter nine).

However, through this option, "PLUS COST" prompts the user to enter the Engineer's breakdown of contract value percentages (if it is a Civil Engineering contract and price adjustment is applied). These percentages will be filed and used by the system automatically every time it is required to adjust the actual values of the work done before using them in producing the controlling and feedback reports. Chapter nine explains how the system uses the data entered through this option in calculating reimbursement for price fluctuation.

The data entry procedure through "Data Preparation" function is shown in detail in Appendix A, figures (1-9).

Having entered the required data manually through the "Data Preparation" option, if it is not available from the other systems, the "PLUS COST" will equally be ready for use.

Figure (5.8) shows the use of the data entered through "Data Preparation", option in producing the required control reports through " PLUS COST".

From the above review, it is understood that "Data Preparation" option has been developed in PLUS COST to provide the manual

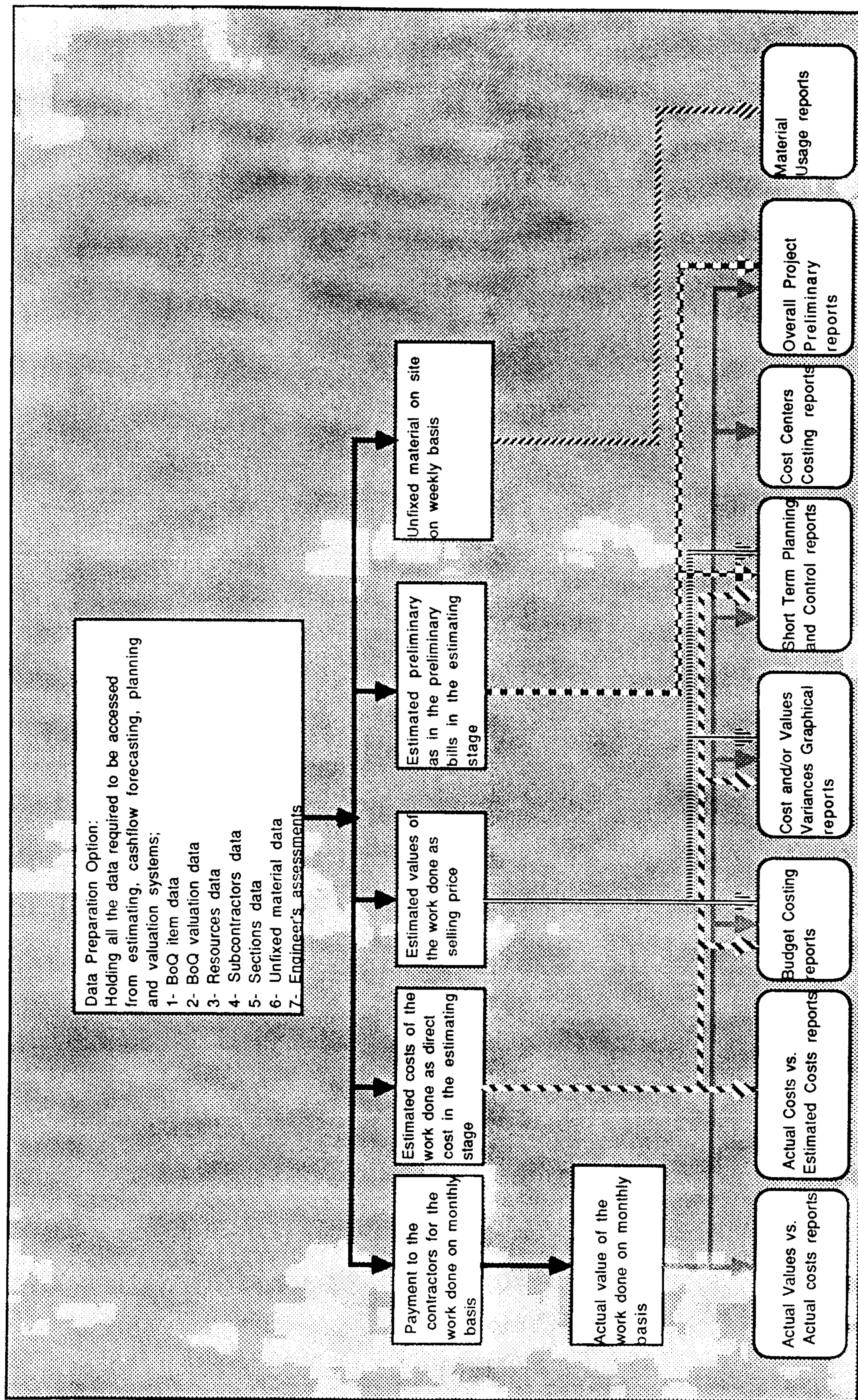


FIGURE (5.8); THE USING OF " DATA PREPARATION " OPTION'S DATA BY THE SYSTEM FOR PRODUCING THE CONTROL REPORTS

option when data can not be accessed from the management files.

5.6 SUMMARY AND CONCLUSION

The following points are a summary of the research work done through this chapter and a conclusion of it:

- 1 - All the computer-aided site management systems already available still suffer from not being integrated to the other management systems. This lack of integration prevents the data produced by the other systems of; Estimating, Planning, Valuation, etc. to be accessed to the site management system. It also prevents the data produced by the site management system being sent back as feedback to the Estimating and Planning systems.
- 2 - Any attempt at producing an integrated construction management system must start from the first stage of construction management which is estimating. All the following stages will be based on the figures that are prepared by the estimator before submitting the tender.
- 3 - I have developed "PLUS COST" to fulfill the promise of achieving the requirements for such integration by using an integrated computer-aided construction management system.
- 4- Through the three parts of this chapter, I have examined the fulfillment of "PLUS COST" being an integrated site management system by reviewing the following:
 - a) the flow of information through each

construction management function of; estimating, planning, cashflow forecasting, valuation and cost controlling;

- b) the information required by the site control and management function from the other construction management functions if these functions are linked to a site control function;
- c) from the above two reviews, I have selected computer-aided systems which are in use to achieve the above functions (one for each functions);
- d) these systems (that have been developed at Loughborough University and claim to be comparing the data they can provide with the data required by "PLUS COST". The data was proved to match;
- e) these systems also have the same computer operating system as "PLUS COST" and are written by the same computer language. That has made the linking of these systems to "PLUS COST" feasible.

5 - From the reviews of point (4) above, I have achieved the second main objective of the research, that is "to examine the feasibility of an integrated site control system linked to the other construction management systems".

6 - If the integration in the data accessing to "PLUS COST"

could not be obtained for any reason, I have developed "PLUS COST" to be able to work on site as a stand-alone (self-contained) system by accepting the required data from the other management systems to be entered manually through the "Data Preparation" option as one of the functions in the system.

7 - The "Data Preparation" function has a set of options in a sequence through which the user must enter the data. So that the problem of entering the same data twice will be prevented.

8 - Because of the two facilities in "PLUS COST" being an integrated system as well as stand-alone system, "PLUS COST" is expected to be the most flexible system ever developed which has those two facilities at the same time in costing and site control of construction projects.

At the end of this chapter and from what has been achieved through it, I expected that the long-time promise of having an integrated construction management system with assistance of the computer-aided software in the construction industry has been fulfilled by "PLUS COST" as a later attempt than those already developed at Loughborough University. In this integration, the estimator's data will be accessed from the first stage of the management through to the following ones. This estimating data will be sent back to the first stage with the actual figures and with some comments on it as feedback. So that a full circle of the management data has been completed by "PLUS COST".

CHAPTER SIX

CHAPTER SIX

PROJECT RESOURCES CONTROL ON SITE

6.1) INTRODUCTION

On any project success or failure is often dependent upon effective management of the available resources, these resources are the standards of cost by which a construction contract must be controlled which are set at the time that an estimate of cost for the work is prepared, when the estimator uses these standards to build-up his estimates of the BoQ item rates. Methods of estimating rarely result in the cost estimate appearing in the form that is required for subsequent comparison and control. It is almost invariably necessary for the form of the estimate to be considerably rearranged before the cost standards can be set up for use in the control function or conversely for it to fit the tendering documents. As far as control is concerned, contractors often divide up their site cost into headings of labour, plant, material, sub-contractors. The other site costs are usually considered as part of the Head Office overheads. The method of dealing with each of these divisions of cost can vary widely because of the different nature of each. The extent to which control over each can be exercised will vary, as will the ability to collect useful data and undertake the control from that point onwards.

The previous chapter (chapter five) has achieved the objective of

having an integrated computer-aided site management system linked to the other management systems by using "PLUS COST". In this chapter and the following ones, I explain how I have also developed "PLUS COST" to be efficient in achieving the "Business Requirements" specification of an efficient and integrated site management. This chapter and the following two chapters also explain the achievements of the Secondary Objectives that I have found desirable to have an efficient site control system (as listed in chapter one).

For achieving the "Business Requirements" specification "PLUS COST" has been developed to deal with the site cost under up to five headings of; labour, plant, material, subcontractor and preliminary (which includes other costs such as non-mechanical plant, temporary work, site overheads and any other site costs). The control of these resources by "PLUS COST" are explained in this chapter and in the following two chapters (seven and eight).

This chapter describes the method of controlling the cost and the performance of the labour and plant on site. It also describes the controlling of the usage and the utilization of the material on site. Through this description I explain the "PLUS COST" achievement of calculating the actual cost of the work done from the usage cost of these resources. The control of the other project resources (subcontractors and preliminaries) will be explained in chapters seven and eight respectively.

In accordance with these resources, I have developed "PLUS COST"

to be a command-driven system that prompts the user to enter the site data which is the same as those used in the site sheets for allocating the resources weekly/monthly. Therefore, I expect "PLUS COST" to be simply used on site by using the same allocation site sheets that are used in the manual system.

Through the chapter and while I am describing the achievement of "PLUS COST" in controlling each resource, I will explain first the manual system that is already in use for controlling the resource on site, the site sheets used and the site data provided. Secondly, I will explain how "PLUS COST" controls the resource more efficiently by using the same data in the site sheets.

In explaining "PLUS COST" data entry of the site data and the controlling reports produced, I will describe briefly the procedure concentrated on the most interesting points, while the full details can be obtained from the appendices (as will be mentioned through the chapter) .

From this chapter, the required site control (cost and performance) of these resources (labour, plant and material) has been achieved efficiently by using the same data as in the site sheets that are already in use by the manual system. That means part of both the third objective and the secondary objectives have been achieved by using "PLUS COST" as an integrated and efficient computer-aided site management system.

6.2) LABOUR CONTROL

In the following review, I explain the controlling of this resource on site. Firstly manually, then by using "PLUS COST". I also explain how I have developed "PLUS COST" to use the same site sheets data in a more efficient way. At the end, the review describes how the entered data in "PLUS COST" can be used in controlling the project site as a whole as well as the resource itself.

6.2.1) Controlling Labour Resources on Site

Labour cost control as one of the most common direct costs incurred in a project is a subject of great importance to the construction industry because labour represents the largest area of controllable cost for most construction companies. At the same time labour control is probably the most difficult of all the resources available to manage and certainly the most expensive (ref. 89). This appears in the motto raised by Gobourn (2) "Each Minute Wasted of a Man's Time is Equal in Cost to Throwing Away a House Brick".

Any mis-management of labour resources (under or over-manning) can lead to considerable losses being quickly incurred, because labour can not be piled like material or easily put "off hire" or "mothballed" like plant whether the labourers are directly employed by the contractor or indirectly by subcontractors.

Having said that, a good system of labour control on site is required emphasizing the problems that must be addressed to

implement an effective computer-aided control system, so that a quick correct reaction can be taken by producing monthly, if not weekly, reports which show the performance as well as the expenses. From that, both planning and control systems may work together to achieve the monetary cost production to be obtained as a monitored operative.

6.2.1.1) Labour Costs and The Manual Systems Used on Site

The total cost of labour is composed of the following elements (ref. 89):

- Man-hours per unit of work (productivity);
- Price per man-hour (labour rate);
- Quantity of work done (performance);

These elements can affect the labour cost in different ways. Any increase in the first and the second element may raise the labour cost, while the increase in the performance of the labourers will reduce the cost.

From these elements, a number of aspects are raised in the control of labour, these are (ref. 6):

- a) the overall control to ensure that sufficient numbers of the required grades are recruited and retained to satisfy the rate of progress required;
- b) the control of the number of men per gang to ensure that the right balance is maintained, enabling each to perform his own tasks without limitation by over-utilization or

- losing time by under-utilization;
- c) the control of man-hours for activities or operations.

Several manual systems for controlling and distributing labour costs are in common use and each has merit on particular types of construction. Timekeepers or Timecheckers are often used on building projects by using a foreman's time card, while the labour ledger is another type of daily labour alternative method used mostly by civil engineering projects to summarize labour costs for analysis purposes.

1) Timekeeper System

This system is very common in building projects which use labourers in gangs by using foreman's cards (or gang's cards). In this system the Timekeeper checks the working hours against the "Daily Time Check Sheet", enters the rate to calculate the bonus required to be paid, if it is based on a target basis. However, in the case of a standard bonus being paid, it serves as a check on the performance of the labourers (i.e. that the labourers are not absent).

The Timekeeper also computes the hours and amounts for each class of work, cross-checking against total wages, and numbers the time cards each day, starting with number (1).

After the foreman's time cards have been collected at the end of a shift, they are checked against the time check sheet, which is prepared daily by the Timechecker. At the close of the shift, the

check sheet and foreman's cards are reconciled.

After the foreman's time cards have been balanced and numbered, they are posted to the payroll, coded and then summarized on the form called a "Weekly Time Sheet", from which the labour cost is derived by using the "Labour Cost Form".

ii) Labour Ledger System

This is similar to the above, but it has an alternative method of summarizing the labour cost for analysis purposes by maintaining a labour ledger, wherein the description of work and the amount of working hours is placed on a separate ledger sheet for each account, totalled and balanced weekly or monthly for posting in total for each cost account in the regular cost ledger. Posting is made directly from the foreman's time cards each day. At the end of a week, the total labour cost for that week will be shown under the total-to-date headings in the labour ledger sheet.

The site sheets which are used in controlling labour resources on site for both Building and Civil Engineering work are shown in Appendix B, sheets (1-9).

6.2.1.2) Computer-Aided Labour Control on Site By Using "PLUS COST"

Control of the labour resources on site by using the available computer-aided systems still mean accounting the payroll of the resources, with no consideration to their

performances. That has made the available software be considered as accounting systems, inefficient in indicating any bad performances that might appear on the site. However, PLUS COST has been developed to consider both the cost and performance of the labour resources on site, by using the same site sheets (allocation sheets) to calculate the weekly cost of each labour resource and produce on-screen reports on the costs and performance of these resources, as explained in the following.

The site control system "PLUS COST" will carry out the function of Labour Control on Site, as part of the whole system, by accessing the data from other function's files throughout the system and passing the produced results to the other functions through the system for use in producing the control reports on site as shown in figure (6.1).

The use of this facility, can be reached by selecting "Labour Control" option. Through this option, the user can:

- A) Edit weekly labour time sheets;
- B) View weekly man-force working hours reports;
- C) View weekly man-force payments reports;

The following describes the data required and the on-screen reports that can be provided through the "Labour control" function briefly.

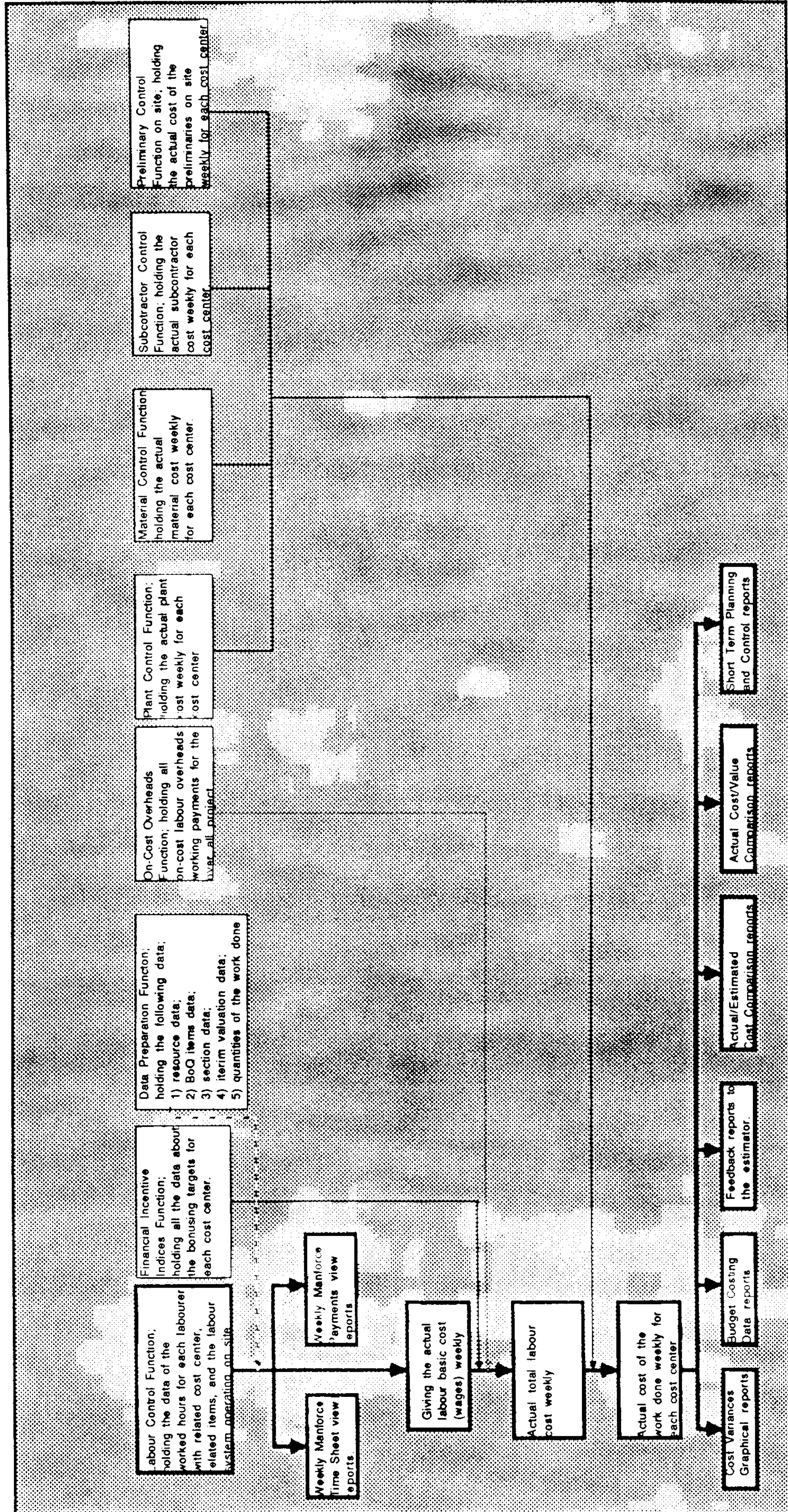


FIGURE (6.1); "PLUS COST" INSIDE PROCEDURE FOR "LABOUR CONTROL ON SITE" FUNCTION

A) EDITING LABOUR TIME SHEETS

Through this option, the data of the "Weekly Time Sheet" can be typed into the system through a micro-computer at the site to be sent back to the main office either by a terminal or loaded on a disk, as explained in chapter five.

If this option is selected, the system will ask if the labour system operating on site is:

- i. Individual Labour System;
- ii. Labour in Gangs System.

After the type of the labour operating system is selected, the system will let the required data enter by answering a set of questions appearing on the screen as an interactive way of entering the required data, till all the data that is supposed to be in the "Weekly Time Sheet" of that week is entered. The required data for each labour operating system are as follows.

i) Individual Labour System

If this system is operating on the site and is selected from the "Labour Control" function, all the weekly performance data of each individual worker will be required to be entered, such as:

- related item code;
- related activity/cost center code;
- weekly total of worked hours for that resource;
- weekly overtime hours (if there is any);

- any extra payments for this resource;
- this week's measurements (by contractor quantity surveyor/measurement engineer).

ii) *Labour-In-Gangs System*

If this system is operating, it must be selected from "Labour Control" function. That will prompt the user to enter all the weekly site performance data of each gang, such as:

- related activity/cost center code;
- this week's quantity surveyor measurement;
- labour resource number;
- weekly overtime hours (if there is any);
- any extra payment for gang.

After all the required data is entered into "PLUS COST" for either labour system, the system will show all that data on the screen with the options: to amend, to file or to exit. So that the amendment can be made on the data, before being filed.

B) *VIEW MAN-FORCE WORKED HOURS REPORTS*

Through this option "PLUS COST" will automatically do all the required calculations inside and produce on-screen reports in the form of a table for the selected week. These reports can be for both types of labour operating systems (individual or in gangs).

The reports assist the Timekeeper and the cost engineer in

producing the labour payrolls.

C) VIEW MAN-FORCE PAYMENT REPORTS

"PLUS COST", provides through this option fully detailed on-screen reports of the payments to the labourers according to the above weekly time sheets after carrying out all the required calculations within the system, including any bonus payments or overtime. These reports are supposed to be done by the Cost Engineer by entering the rates against each labourer as well as any bonuses the labourer is entitled to be paid. Therefore, the system "PLUS COST", will save time for the Cost Engineer by providing him with on-screen reports in a few seconds for the selected week, with an option of including the bonuses in the report. These reports can be for both types of labour operating systems (individuals or in gangs).

The data entry procedure through the "Labour Control" transaction, with its on-screen reports are shown in detail in appendix C, figures (1-6).

6.2.2) Control of Other Labour Costs on Site

There are some other labour costs in addition to the basic wages which are added to the wages to determine the actual gross total labour cost on site, so that these costs require consideration in any site control system. These other costs are:

- Financial Incentives;
- On-Cost Labour Overheads.

These other costs and how "PLUS COST" has dealt with them are explained as follows;

6.2.2.1) Financial Incentive Schemes on Site

Financial incentive schemes are widely used throughout British Industry as an active motivation theory which is called "Money as motivater" (ref.6), so that money can be said to embrace all the five money effects which are (ref. 6):

- 1) achievement;
- 2) recognition;
- 3) the work itself;
- 4) taking responsibility;
- 5) the chance to advance.

As well as the results from the survey carried out by Mackenzie (96), on 30 firms which approved the payment of financial incentives to construction operatives as an inherent part of wage systems and industrial relations, he reached the conclusion that all the interviewees tended towards the principle that money is the only strong motivater at their disposal.

Therefore most management systems have to be designed to suit the particular circumstances in which they are to be applied, and incentive schemes are no exception. There are probably as many different bonus schemes as people paying bonuses. Financial incentives may have different definitions but here they are taken to mean "any payment made to an employee over and above the basic minimum wage level normally set for that employment".

"PLUS COST" deals with the incentive schemes which may influence the calculation of labour cost on site as bonuses being paid to the labourers. In the following financial incentive review, I explain the following;

- A) Financial Incentive Schemes Available.
- B) Bonuses In the Manual Site Systems.
- C) Bonusing Schemes used by "PLUS COST".
- D) Control Bonusing Schemes on site by using "PLUS COST".

A) FINANCIAL INCENTIVE SCHEMES AVAILABLE

Three types of incentive schemes are identified by Pilcher et al (97), according to the way of paying the incentive related to:

- i) Payment By Results (PBR); where incentives are related to production output.
- ii) Merit Incentives; where payments are made as a reward for inherent quality.
- iii) Policy Incentives; where a premium is paid as an inducement to join and remain with a certain employer.

Each type of scheme can then be divided into many other sub-divisions as shown in the following.

i) Payment By Result Schemes

The types of incentive schemes which have the same base of PBR are (ref. 94):

- Piecework Scheme;
- Direct Bonus Scheme;

- Geared Bonus Scheme;
- Indirect Bonus Scheme;
- Measured Daywork Scheme;
- Profit Sharing Scheme.

ii) Merit Incentive Schemes

Payment over and above the normal basic rates are often made by virtue of the man's skill, experience or responsibility. Since these payments are not related to performance on a daily or weekly basis, they will normally consist of an addition to basic wages in the form of either:

- Standard Bonus Scheme;
- Plus Bonus Scheme;
- Other Benefit Scheme.

iii) Policy Incentives

This type of bonus is encountered on the fluctuation in the demand for construction and the consequent fluctuations in the construction activity. The supply and demand for particular classes of labour can vary dramatically and may give rise to the need to pay over the normal basic rate for particular men.

The method of paying of such a premium can take the form of either a more attractive PBR target, a higher plus rate or standard bonus.

Mackenzie (94), has described each scheme in detail with its

method of calculating the bonuses on site.

B) BONUSES IN THE MANUAL SITE CONTROL SYSTEMS

Site staff usually have the responsibility of completing time sheets indicating the number of hours worked by each operative and the amount of bonus earned in the current period. When an operative commences, information will have been given to the accounts department of his basic rate, any additional rates and any travelling time or amounts that are to be paid for subsistence.

From these records, the accounts department will produce the wage sheets and determine the labour costs which will form part of the total contract cost.

Depending on the breakdown of information provided (i.e. by trade, by gangs or other groups), valuable management information will be provided at the time the labour costs are calculated.

C) INCENTIVE SCHEMES USED BY "PLUS COST"

There are so many different incentive schemes, up to 44 schemes operating on site (refs. 94 and 96), that it proved impossible to use all these schemes in "PLUS COST" for calculating bonuses on site. However, I have selected the most commonly used schemes, two of them are PBR schemes used by 27 out of the 30 firms surveyed by Mackenzie (96), and by the thirteen companies surveyed by this research (ref.4). These schemes are:

- i) Piecework Scheme;

- ii) Standard Bonus Scheme;
- iii) Profit Sharing Scheme.

i) *Piecework Scheme*

After the targets have been put in, either by labour only subcontractor in competition with others, or given to him by the contractor, or negotiated between the two, these targets are invariably in the form of prices, (a price per unit of output, or sometimes expressed in terms of hours per unit of measurement, at a given time rate, is set for each item of work).

The contractor's quantity surveyor will measure the work at fixed intervals (usually a week). The total pay is equal to the number of units produced in that interval, multiplied by the target price after deducting from it the retention (usually 5%) the previous payment (if the measure is to date from start of subcontract), insurance and CITB levies (ref. 94)

ii) *Standard Bonus Scheme*

This describes a regular payment, which usually earns the title " Bonus ", because it appears in the box with that name on the wage packet, It is merely a convenient method of increasing a man's basic pay.

The target hours for the worker are set by the manager to complete any job or activity. The time he spends to complete that task will be calculated and if he finishes the work in less time than the target, payment will be based on the target multiplied by

the hourly rate.

iii) Profit Sharing Scheme

The system used by the construction firms under this heading is not quite a profit sharing scheme, but is a mixture of Piecework and Profit sharing.

In this system, the Bonusing Manager will use the estimates as (£/unit of measurements) as rates of BoQ, from which the targets are set at (10-20%) less than the labour figures in the BoQ item rates. These targets will be in the form of (£/unit of measurements). At the same time, the due working hours for each labourer in the gang are set, from which the working hours for the whole gang is calculated and then the bonus shares for each labourer in the gang is determined.

Measurement is calculated by the contractor's quantity surveyor on a weekly basis, from which the target labour cost of the work done is calculated by multiplying the targets with the measurement. The weekly working hours for that gang is multiplied by the labour rates (£/hours) to find the labour cost as wages. From the comparison between these two figures (the money paid to the gang as wages and the target labour cost of the work done), any extra money over the wages to get the target will be paid back to the gang according to their bonus shares.

The bonusing sheets used on site are shown in Appendix D, sheets (1-6).

D) COST BONUSING SCHEMES ON SITE BY USING "PLUS COST"

In the available site management software, the bonusing system has just been considered in the labour payroll calculations. To achieve accurate labour site cost figures, PLUS COST has considered these other site labour costs in controlling the labour resources on site. The accurate cost figures will also be used in controlling the project as a whole and producing the control and feedback reports. That has made PLUS COST more efficient and effective in controlling the labour resources as well as the project site as a whole.

This function has been added to PLUS COST, as a site control system to achieve all the calculations of the bonuses on site (if one of the bonusing schemes operating is on site). The bonuses will be added to the labour basic cost from working hours to produce the actual gross labour cost (payment). This actual gross labour cost will then be added to the other resource costs such as: plant, material etc. to produce the actual gross cost of the work executed, as shown in figure (6.1).

The user has just the task of updating the data in the Bonusing Indices, and "PLUS COST" will do all the calculations automatically within the system, whenever the actual gross cost of labour is required.

The entry of the data in the system is achieved by selecting the "Financial Incentive Indices" option. The system will ask which of these three schemes is operating on site:

- Piecework Scheme;

- Standard Bonus Scheme;
- Profit Sharing Scheme.

From selecting the type of scheme required, "PLUS COST" will ask the required data for that selected incentive scheme to be entered by showing a set of questions on screen to be answered interactively.

The required data for each type of incentive scheme is:

- Piecework Scheme:

- * cost center number;
- * bonusing targets (hours/unit of measurement);
- * additions for daywork consideration (%).

- Standard Bonusing Scheme:

- * labour resource number;
- * bonus targets (hours/unit of measurement);
- * standard bonus unit.

- Profit Sharing Scheme:

- * related cost center number;
- * gang number;
- * total gang working hours;
- * bonus target (pounds/unit).

After the required data is entered, "PLUS COST" will show all the

entered data on the screen with the options; to amend, to file or to exit. The required amendments can be undertaken, if there are any before the data is filed.

The data entry through this function is shown in Appendix E, figures (1-5).

6.2.2.2) On-Cost Site Overheads

Any contractor must place himself in a position to secure work and then to control its execution. In order to do this he has to have an office which incurs rent and other costs, he must have someone to attract work and someone to price it. These overheads are usually considered by the estimator while putting his estimates either as addendums to the basic unit costs of the resources, or as preliminaries included in BoQ preliminaries items, or to general overheads which are usually estimated as a percentage of the project in the company's total head office overheads.

Whatever the category of the overheads incurred, consideration must be taken into account to be included in any site control system. The following on-cost overheads review includes:

- A) Project Overheads; Definitions and Their Categories;
- B) On-Cost Site Overheads available;
- C) The Allocation of On-Cost Overheads On Site Manually;
- D) On-Cost Site Overheads Control By Using PLUS COST.

A) PROJECT OVERHEADS; DEFINITIONS AND THEIR CATEGORIES

Two types of overheads can be identified in any contract work, the first one is incurred from executing the work and keeping it as productive as required and can influence the work on site directly, whilst the second usually comes from the money that is spent on administration in the main office of the company outside the whole project and can influence each project proportionally and indirectly according to the contribution of each.

At the same time, the site overheads can be divided into two distinct types:

- i) fixed overheads;
- ii) variable overheads

1) Fixed Overheads

Few overheads are rigidly fixed during the full period of a contract, but many remain more or less unchanged by the current labour strength at any particular time in the contract. These include items of both labour and plant. Examples are:

Site Offices	Chain Boy
Toilets	Attendance on clerk of works
Temporary Roads	Clean Public Roads
Staff	Plant Maintenance
Mini Buses	Temporary Services

These items are frequently priced under the preliminary section of

the BoQ and are therefore often referred to as preliminaries in standard costing systems.

The estimated cost or budget for these overheads can be spread over the contract to obtain weekly standards.

ii) Variable On-Cost Overheads

These overheads are geared directly to the number of men employed on site and vary as that number changes.

These include such items as:

Annual holiday stamps	Lodging allowance
Public holiday with pay	General insurance
Inclement weather time	Sick pay
Travelling time allowance	Graduated National Insurance
Fares	Training levy

The pricing of these variable overheads is frequently calculated as an on-cost to the basic labour rates and the BoQ items priced gross.

On the other hand site overheads can be divided into three basic categories:

1. wage sheet overheads;
2. allocated labour overheads;
3. allocated plant overheads.

These overheads are usually listed as an addendum in the gross cost statement which means the labour gross rate will be slightly

higher and will include these overheads.

The research has dealt with site overheads only, both fixed and variable. The fixed overheads are unchangeable by the labour strength as explained previously. So that the research has considered and priced them as preliminary items as explained in chapter eight. The variable site overheads or as they are called, On-Cost Overheads are frequently calculated and added as on-cost to the basic labour cost as part of labour cost.

B) ON-COST SITE OVERHEADS AVAILABLE

There are many overheads which incur costs on site and need to be added to the basic labour costs when they are estimated as well as for control and monitoring purposes. Some of these overheads are as listed below (ref. 2):

- Number of working weeks per year:
- Travel Time Allowance:
- Wet Time:
- Public Holidays:
- Tools Allowance:
- Sick Pay:
- Miscellaneous Payments:
- Fares:
- Subsistence:
- Holiday Stamps:
- Redundancy and Training Levy:
- Graduated National Insurance:
- Plus Rates:

- Supervision:
- Cost of Absenteeism:

C) THE ALLOCATION OF ON-COST OVERHEADS ON SITE MANUALLY

Considering the three categories of these overheads which are:

- i. wage sheet overheads;
- ii. allocated labour overheads;
- iii. plant overheads.

The allocation of each of these overheads on site is as following:

i) Wage Sheet Overheads

By using the costing system, the wage sheet overheads can readily be abstracted from the wage sheets, for example, total cost for the week of lodging allowance, sickness payments, holiday stamps, etc.

Flat rate overtime working must be allocated in the same manner as normal working hours, but the non-productive overtime requires to be kept separate and calculated as an individual cost item.

The above is right if the standard costing system is applied, but in the unit costing system, the wage sheet overheads can not be included in net unit costing except as an addendum list at the end of the unit cost statement.

ii) *Allocated Labour Overheads*

For any costing system operating on the site, certain non-measurable items are best dealt with as an overhead cost, such as erection of site office, unloading of materials, laying temporary roads etc. These are usually considered as preliminaries or may be costed as an addendum to the cost statement. However, these items can be incorporated into the general standard cost statement under the heading of overheads.

iii) *Plant Overheads*

All these overheads such as vibrators, fuel and oil, mixers, dumpers etc. are usually considered as preliminaries in Bill of Quantities items in both types of costing systems.

D) *ON-COST SITE OVERHEADS CONTROL BY USING "PLUS COST"*

In PLUS COST, the first type of these overheads (Wage Overheads) has been considered as on-cost overheads which are part of labour gross rate, while the second and the third type are considered in the system as preliminary items in the BoQ as explained in Chapter eight .

From the description of this type of overhead, it can be understood how the estimator can take these overheads into account while he is preparing his estimates for the project resource rates, and to make the comparison reports show like-to-like figures to keep the

effectiveness as well as the simplicity in using these reports.

Despite the necessity of this site cost, which influence the accuracy of the labour actual cost figures, none of the available site control systems has included this cost in their labour site cost calculations. PLUS COST, for the first time, has considered the on-cost labour overheads, in its calculations of the labour cost, for controlling the project site and producing the control and feedback reports.

"PLUS COST" has this function to enter all the on-cost overheads weekly which are considered by the estimator in building-up the gross labour rate (basic rate plus on-cost overheads as percentage).

These overheads cannot be added directly to the labour costs, because of the difficulty of allocating these to a specific cost center, so that the system (PLUS COST), will do all the calculations on these overheads separately, then add to each cost center a proportion according to the quantity of the work executed by each cost center.

However, to enter the on-cost site overheads into "PLUS COST" weekly, the option "On-Cost Overheads Control", is required to be selected which will lead to a list of options. These options are:

- Editing Weekly Overheads Payments;
- View Weekly Calculation Reports;
- View Monthly Calculation Reports.

By selecting the first option, the system will list the most common twelve on-cost overheads (Wages Overheads) (as listed before), one after the other and let the user enter the weekly incurred cost against each. If there is any other overheads not shown, they can be included within the "Miscellaneous Overheads" which are supposed to include any other on-cost overheads apart from those listed.

After all the costs have been entered, the system will show all the entered cost again with their related on-cost overheads. followed by three options; to amend, to file or exit. Any amendments can be undertaken, before filing the data.

The second and the third options of this function, will give weekly and monthly on-screen view reports respectively for any selected week number or month date. These reports give the contractor an idea about the money being spent as on-cost labour overheads. From which, he may re-consider the money spent on such overheads for the next period of time.

The data entry and some examples of on-screen reports of this function in "PLUS COST", are shown in Appendix F, figures(1-5)

This weekly on-cost data will be stored in the system to be used in the time of cost calculation, by dividing the total cost of these overheads between the cost centers proportionally according to the work executed in each center for that week. The share of each center will be added to the total cost of labour (wages and

bonuses), which can then be compared with the estimated labour cost (gross cost) of that cost center.

The flow of data from this function and its use in producing the controlling reports on site are shown in figure (6.2).

6.3) PLANT CONTROL

The degree of involvement of plant in any particular project will be dependent upon the nature of the project. A small construction project may require no more than the contractor's own available plant, or it may revolve totally around the availability of a single item of plant of which there may be no more than two or three in the world and that they may be booked for several years ahead and/or be able to operate only during certain weather windows.

Regardless of the project conditions as well as the acquisition of the plant by the contractor, the plant is still one of the resources which need good consideration to keep them more efficient and economic and overcome any problems of apparent mis-allocation or misuse at a later stage.

However, considering Plant Control, plant like labour and material control can be linked to the contract programme as a resource to give its requirements and demand levels (ref. 84). Plant has generally been allocated to specific items or trades

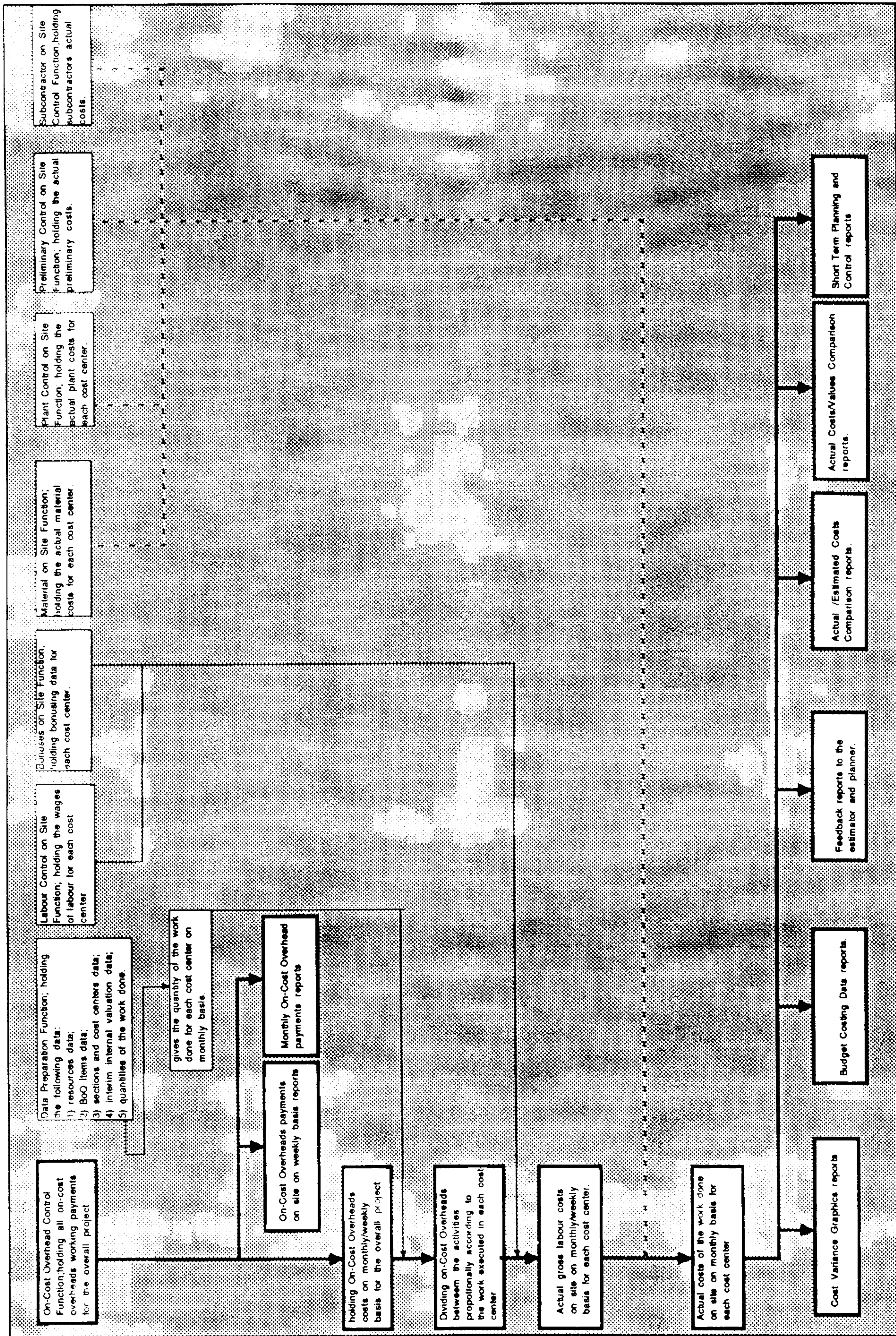


FIGURE (6.2); "PLUS COST" INSIDE PROCEDURE NETWORK OF "ON-COST OVERHEADS CONTROL" FUNCTION

and an unwanted coincidence between two items requiring the same item of plant may well be able to be reduced by allocating a substitute item if a duplicate is not available, perhaps allowing greater usage of a larger capacity plant item which might otherwise be designated as idle, thus allowing more efficient and economic usage. However, substitution to overcome conflicting work items must be remembered and recorded in the contract programme to overcome any problems of apparent mis-allocation or misuse at a later stage. Furthermore, the programme, as it is regularly updated must be able to report this substitution status as invariably there are an assortment of changes to the programme as work progresses for equally assorted reasons. Thus the original conflict of requirement may well disappear, only to reappear with a conflict of requirement for the substitute item of plant.

At the same time (ref. 91) during the period a mechanical plant item is on site, further control must be exercised to ensure that the required output of production and reasonable fuel consumption is being obtained.

To provide an efficient Plant Control on site, the following aspects must be considered (ref. 91):

- 1) ensuring plant required is on site;
- 2) ensuring plant planned output is achieved and maintenance performed while on site;
- 3) ensuring plant is removed from the site, after the work is complete.

From what has been said above and in considering "PLUS COST" system as a site costing, monitoring and control system, the plant control facility in the system has had the ability of calculating the costs of plant on site as well as the plant usage from which the utilization can be indicated weekly.

Through the system, the first two points can be obtained which make sure that the proper plant is on site and the planned output is achieved. The third point is supposed to be achieved by using a planning system on site which has the ability of scheduling the plant usage according to the project activities.

6.3.1) Plant Allocation and Cost Control Procedure on Site Manually

All the contractor companies in general have similar procedures in allocating, calculating and controlling the plant costs even though they are different in their ways of providing this plant.

The plant cost allocation and control on site follow the under mentioned procedures:

1. As in labour resources, by using the Plant Time (Allocation) Sheet, large plant can be allocated on an hourly basis, while the small plant can be allocated on a weekly or even monthly basis. After a week of work, all the used plant will be allocated to their cost centers in the "Plant Time Sheet" that is prepared for the work executed through that week. This sheet is usually

prepared each week by the site foreman, it describes the work to be performed, monitors the number of hours spent on the task in that week and also notes the non-productive time incurred.

2. The true hire rates must be added if the plant is hired, then the hire charge is applied; if the plant is owned by the contractor, then the contractor's internal hire rate applies.
3. By using the External/Internal Plant Return Sheet, the weekly cost can be calculated and compared with the previous week as well as the monthly costs.
4. For controlling purposes, especially for items which are hired, Task Sheets are usually used as well as Time (Allocation) Sheets. This form (Task Sheet) serves the purpose that it records the working, standing and breakdown times. Thus by recording such details, appropriate actions can be taken to increase productivity in the following weeks as well as plant utilization in that week can be calculated.
5. In addition to the Task Sheet, another sheet may be used to record the various items of plant available on site during the week, this form is called "Weekly Plant Record Sheet".

The site sheets used for allocation and control plant cost on site are shown in Appendix G, forms (1-6).

6.3.2) Controlling Plant On Site By Using "PLUS COST" System

Before explaining how the system can achieve the "Plant Control on Site" function, a list of points are required to be considered by the user before using this function, these points are:

1. Because the system works on Weekly Time (allocation) and Task sheets in entering the plant data from the site, the light or heavy plant will have the same means of costing on a weekly basis and the daily sheets for heavy plant can be collected weekly then entered into the system.
2. All the costs which include fuel, oil, grease, spares, tyres and parts that are not included in the hire rate can be entered into the system as "Operating Costs".
3. Any sort of cost that may be encountered unexpectedly can be entered as "Extra Money" through the system.
4. The Charges for transportation when the plant is hired from an independent hire company, for delivering and moving the plant from the site, can be entered as "Preliminary Items", as explained in Chapter 8, because of the impossibility of being allocated to any cost center while it was on the site.
5. To overcome the difficulties when the plant is working for more than one cost center at a time, the question of Dedication Percentage has been put into the system, so that the user can enter the dedication percentage for using the plant for each cost center.

6. In the case of plant working for many cost centers such as a tower crane, where it is impossible to indicate the percentage for each center, such plant can be considered then as one of the Preliminary Items as explained in Chapter eight.

Having considered these six points, this facility has been developed in "PLUS COST" to be desirable by whatever plant control system used by the contractor. Also the system has been developed to accept the data similar to that required to be filled in the site sheets such as "Task/Time Sheets", which are used by the construction companies in their manual control systems. The rest of the calculations are undertaken within the system to calculate the actual plant cost weekly, which will be added to the other costs (i.e. labour, material, subcontractor, etc.) to find the actual cost of each cost center weekly. The actual cost of the work done can then be produced, from the previous calculation, monthly, and this cost (monthly actual cost) will contribute in producing the print out control and feedback reports on site through the system (PLUS COST).

According to the above explanation, PLUS COST is expected to be the first site management system, amongst the available systems, that has considered all the plant control on-site difficulties and provided an efficient plant control function to control the cost and performance (usage) of each plant resource on site, and produce accurate cost figures to be used in producing overall project cost control and feedback reports.

Figure (6.3) shows a flow chart which explains how the data from this function Plant Control, contributes in producing the required controlling and utilization reports on site.

"PLUS COST" is providing this function, if the "Plant Control" function has been selected. The function will provide the following options:

- i. Edit task sheets;
- ii. Edit time sheets;
- iii. View task sheets;
- iv. View time sheets;
- v. View plant cost reports;
- vi. View plant utilization reports;

1) Editing Task Sheets

This option will prompt the user to enter the plant on site data that are similar to that in the Task Sheet on site, which is supposed to be filled in by the foreman. The weekly task data for each plant resource number is required to be entered, such as:

- * related cost center code number;
- * weekly hours worked;
- * weekly standing hours;
- * weekly breakdown hours.

After all the above data has been typed in, the system will show on screen all the entered data with the options: to amend, to file or to exit.

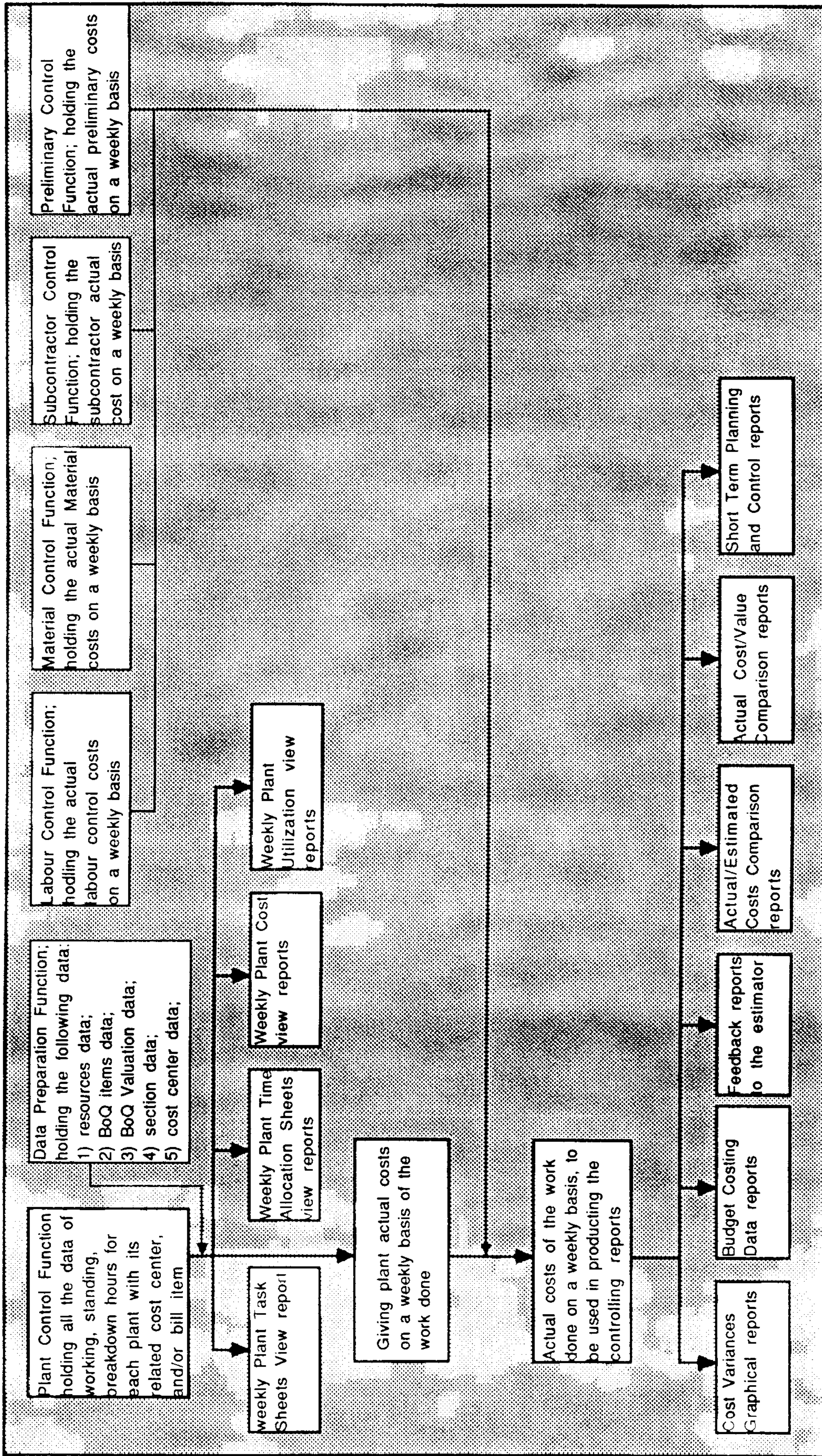


FIGURE (6.3); "PLUS COST" INSIDE PROCEDURE NETWORK OF "PLANT CONTROL ON SITE" FUNCTION.

ii) Editing Time (Allocation) Sheets

Through this option, the system will prompt the user by a set of interactive questions to enter all the data which is similar to this in "Plant Time Sheet" used on site and is supposed to be filled in by the foreman on site. For each plant resource number, the operating data is required to be entered such as:

- * related cost center number;
- * dedication percentage (%);
- * weekly hours worked;
- * weekly operating (running) costs;
- * any extra costs.

And again the system will show the entered data with the same three options as before: to amend, to file or to exit.

iii) View Task Sheets

Through this option and the next one "PLUS COST" behaves as a documentary system by filing all the Weekly Time/Task Sheets under their week's number and viewing them on the screen whenever required to give the user, for any selected week, a full detailed report of plant usage hours compared with breakdown and standby hours.

Through this option, the system will ask for the required week number to be entered. The Task Sheet of that week will be shown on screen in a form similar to that in the real Task Sheets used on site by the foreman. These reports hold the data which were

entered before, through option "Editing Task Sheets" .

iv) *View Weekly Time Sheets*

Through this option, the system gives the user the facility to check any Time Sheet entered before, through the option "Editing Time Sheets" by selecting the required week number of that sheet and the user will get an on-screen report in a form similar to that of the Time Sheet used on site. These reports will provide, for any selected week, all the details about the working hours of each plant resource. These reports will be used for checking the expected working hours for the plant resources with the actual.

By this option and the previous one "View Task Sheets", there will be a better system of keeping and checking the plant control sheets in the company, when the system "PLUS COST" will file all these sheets. The Time/Task Sheet will be checked, by just typing in its week's number. That will save a lot of clerical work (as time and paper work).

v) *View Plant Costing Reports*

This option will prompt the user to select the week's number to give him an on-screen report which shows the working, operating (running) and extra costs with their totals after doing all the calculations within the system by using the plant hire rates which should have been entered previously through the "Data Preparation" option as explained in Chapter five. If any of the plant rates for the resources in that selected sheet have not

been entered before, a warning message will be shown on the screen to tell the user "why the calculations have not been proceeded to produce the required report on the screen". The user will use the weekly actual cost of each plant resource in the report to compare it against the expected cost as well as the money to be paid as hiring cost.

vi) View Utilization Reports

To achieve an efficient plant control on site by the system, this option has been put in the system to show on the screen the utilization (performance) of the plant resources for any selected week, as a percentage of the actual working hours from the total hired hours which includes; standing and breakdown hours (i.e. out of use), the system will give the utilization in remarks according to these percentages as follows:

<u>The Percentages</u>	<u>The Remarks</u>
100% - 80%	very good utilization
79% - 60%	good utilization
59% - 50%	poor utilization
less than 50%	very poor utilization

From this report, the user could quickly obtain a complete picture on the performance of the plant resources in that selected week. A corrective action may be ordered on site to improve the usage of the plant resources for the next period of time, if any undesirable indication is shown in these reports.

The data entry of "Plant Control" option and its on-screen reports are shown in detail in Appendix H, figures (1-9).

6.4) MATERIAL CONTROL

It has been shown through the recent investigation (ref. 115) that material losses on building sites are far greater and approximately 2 to 3 times those allowed for in the estimate, and it is suggested that if the material variances is reduced by half, then the profit on a contract could be doubled. Therefore material control should become a policy of every firm of any size, and an accepted part of training and practice of all those engaged in the production process.

So far materials have not been considered in any site control system. This is because it is more difficult to control material variances than anything else. Once again this is largely due to the nature of the site conditions.

The factors which add to the difficulty of keeping precise control of material costs can be divided into two; price and quality variances (ref. 7). Each factor includes a set of difficulties as follows:

- Price Variances:

- a) inflation;
- b) Changes in the buying situation since the estimate was prepared (e.g. bulk buying discounts, shortages and changes in quality

amended by the client or available at the time.)

- Quality Variances:

- a) wastage and breakages;
- b) theft and loss;
- c) short deliveries;
- d) remedial work;
- e) delays in recording systems;
- f) inaccurate site measurement of the work done.

Carefully compiled, comprehensive records would enable all these variances to be calculated for various material cost codes, but the cost of undertaking this work would probably far exceed the potential savings so any material control measures must be cost effective. The savings from both avoiding waste and reducing delay in building operations must be greater than the cost of implementing the measures.

6.4.1) Material Handling Responsibilities in The Head Office Organization

The control of material on site must be effected from the inception to the completion of the project as part of any site control system which means that any approach of controlling the material must start at the tender stage when the contractor's estimator commences pricing the bills and eventually after consideration by the director, the tender is submitted as shown in figure (6.4).

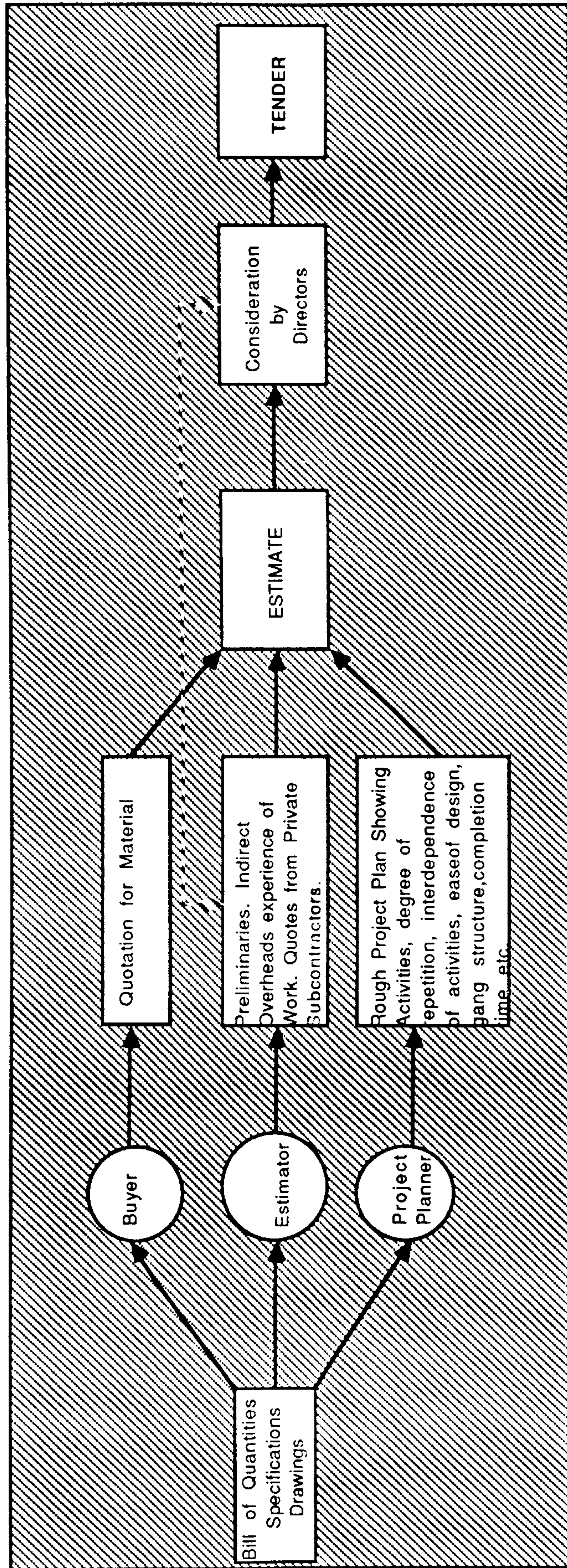


FIGURE (6.4); THE MATERIAL INVOLVEMENT IN PRICING THE TENDER BY THE ESTIMATOR

After the tender has been accepted, the Planning Engineers will start establishing detailed project plans, either as bar charts or networks. From these, the buyers in the Estimating and Buying Department in the head office make up their programmes for delivery of material and budget for purchases. After this, the orders are placed (ref. 3).

At the construction stage, the Buying Department will use the order records and project plan and budget in keeping its involvement in controlling material on site by keeping records of ordering and checking the current total of material delivered against the total fixed or unfixed on site, to establish pilferage, excess waste, excess breakage, errors in ordering, etc. until the practical completion of the project, figure (6.5).

6.4.2) Material Handling on Site Manually

Material handling on site and the documents that are used on site to control the material as shown in figure (6.6), are usually in sequence as follows (ref. 92):

1. After the supplies have been nominated, all the information about them must be recorded such as supplier's number, name, address, telephone number etc., and must be kept in the Head Office for any future requirements.
2. The next stage is making orders for the estimated quantities of the required material, making sure of correct times and dates of deliveries. So that all orders must have information concerning order number,

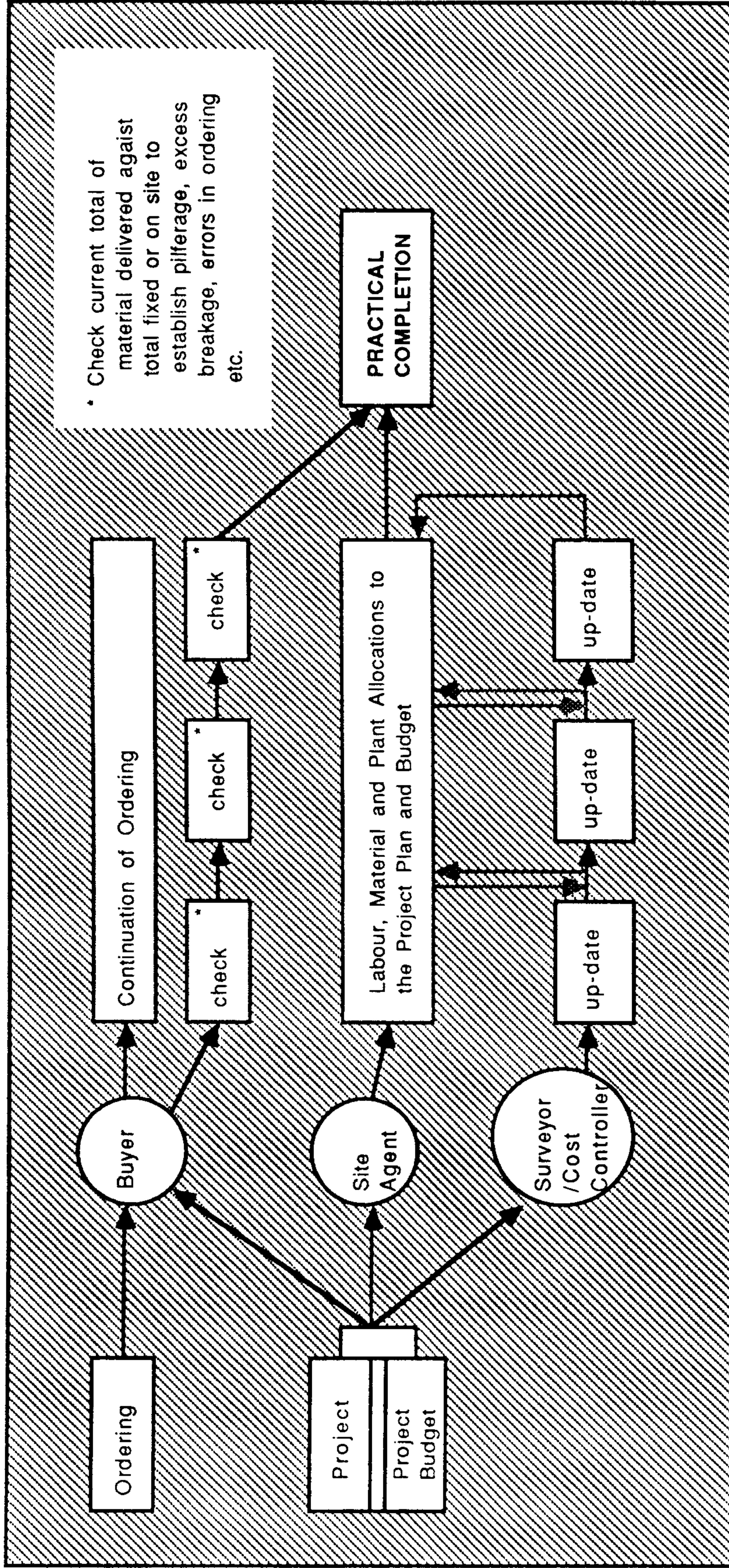


FIGURE (6.5); THE MATERIAL CONTROL ON SITE AT THE CONSTRUCTION STAGE

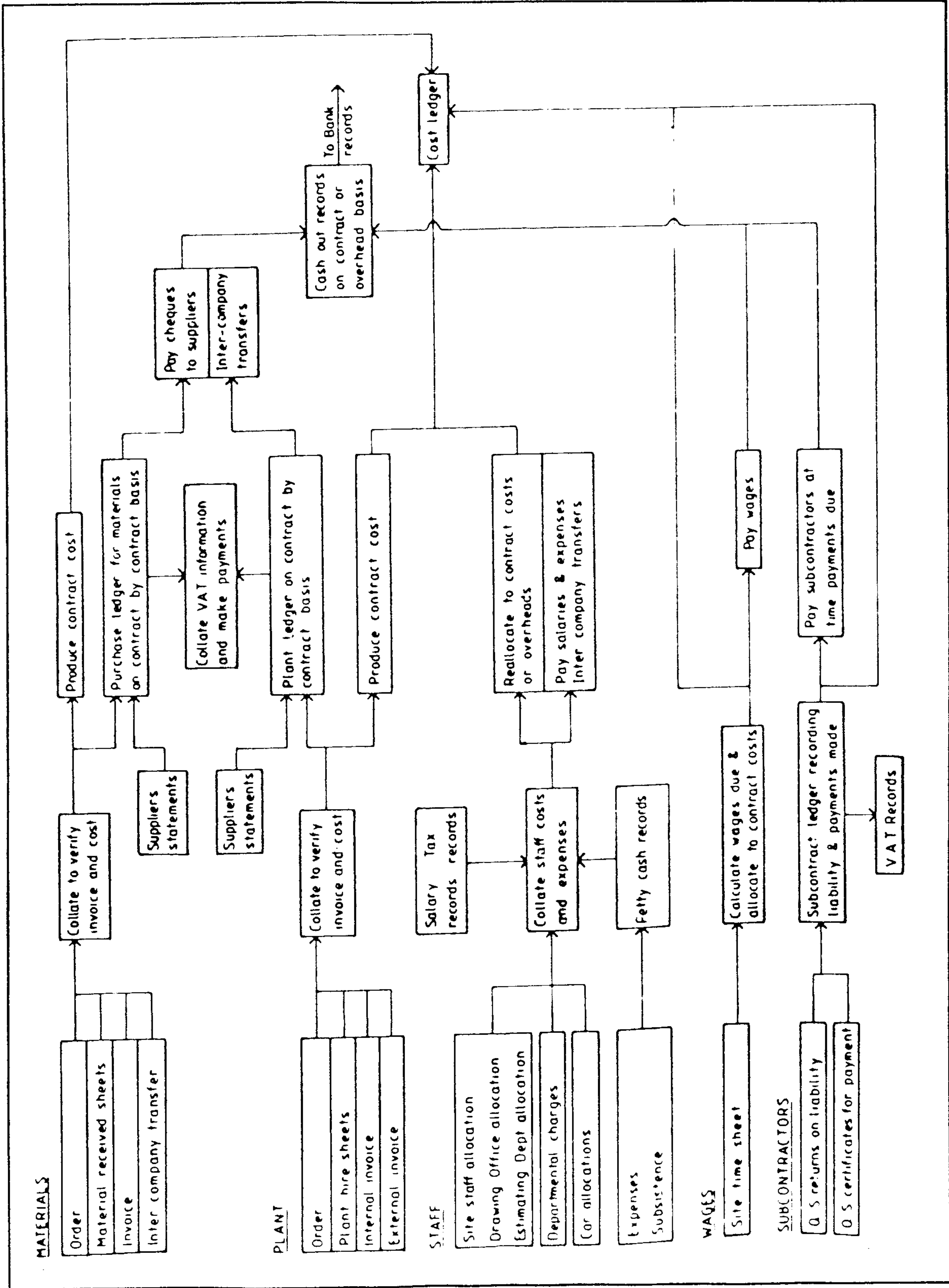


FIGURE (6.6); THE MATERIAL CONTROL SEQUENCE ON SITE WITH OTHER RESOURCES

registration number, supplier's number and name, date of orders, date of delivery, discount on order (if any) and the material ordered.

3. When the deliveries start to arrive on site, the checker at the site will note all material delivered to the site daily and then send it to the Regional Headquarters. This information can then be used in the monthly cost reports, and as a check against the details shown on the invoices received from the suppliers.
4. Material Utilization Evaluation; the purpose of preparing a material utilization evaluation is to calculate the yield to ascertain whether or not the allowance made by the estimator is being achieved.
5. Losses due to material wastage can be very significant and it is important to ensure that wastage on major material is monitored weekly. Even though this may not give an accurate statement of the wastage situation from a straight comparison of "Delivered" with "Measured for Valuation", it would give an idea about how the material usage is going on site. This report comes weekly in a cumulative form of information.
6. Material Fluctuation Claim Sheet; as one of the difficulties of controlling material is price and quality variances as mentioned in the beginning, this sheet is used to record such fluctuation which arises because the time between tendering and obtaining the contract may be long and also allowing for the length of the project. Because of that long period of time the market

prices of material may fluctuate from that in the BoQ.

The site sheets used in controlling the material on site are shown in Appendix I, forms (1-5).

6.4.3) Material Handling and Controlling on Site By Using "PLUS COST"

The "Material Control" function has been added to "PLUS COST" to achieve the material handling on site which is usually undertaken by reserving a good number of staff on/off site to do the data collection as well as the clerical work and that will need time and paper work.

"PLUS COST", for the first time, has been developed to carry out the material handling and control on site by following the same sequence used in the manual way (as explained in the previous section), by dealing with all the documents that are used on site in controlling the material usage and cost on site, such as suppliers, orders, deliveries, etc. The weekly actual cost of the material resources will be calculated through this function to be added to the other project costs such as labour, plant subcontractors, etc., to produce the actual cost of the work done. Also through this function, "PLUS COST" also provides both type of reports, (on-screen and print out), to assist in controlling the material handling and usage on/off the site.

None of the available management software has this facility of material control, and this has made their site control still

inefficient in controlling the project resource on site.

Figure (6.7) shows the data flow chart of the "Material Control" function and how this data is used by the system to produce the controlling reports.

If this function is required to be used, the option "Material Control" must be selected which offers a set of options:

- i. Edit Suppliers;
- ii. Edit Orders;
- iii. Edit Deliveries;
- iv. Determine Fixed Material;
- v. View Margins on Deliveries;
- vi. View Margins on Orders;
- vii. View Material Summary;
- viii. View Orders Summary;
- ix. View Supplier's Accounts;
- x. View Material Utilization;
- xi. View Material Wastage.

1) Editing Suppliers

Through this option, all the general data about the suppliers can be entered, such as Supplier code number, name, telephone number, address and his contract note.

This data will be shown on the screen with the options; to amend, to file or to exit.

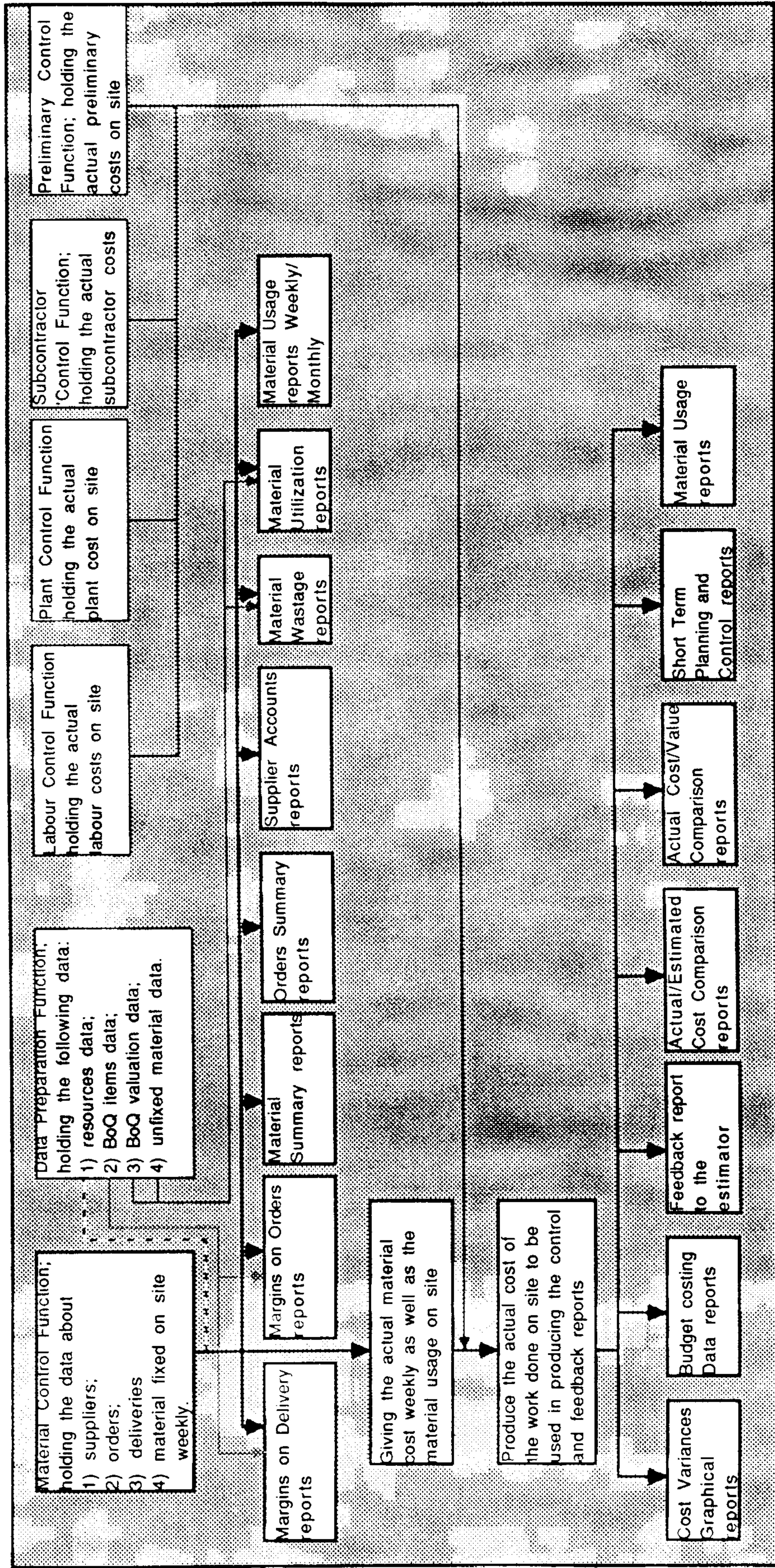


FIGURE (6.7); THE "PLUS COST" INSIDE PROCEDURE NETWORK OF "MATERIAL CONTROL ON SITE" FUNCTION.

This data will be stored in the data files through the system to be called for any addition or amendment to the data.

ii) *Editing Orders*

This option is used for adding all the data about the orders made with any of the suppliers entered in the previous option, the data is:

- Order number;
- Order registration number;
- Supplier's number of this order (the supplier's number must be one of those entered in the previous option);
- Order date;
- Delivery due date;
- Discount on the purchasing price as (%) if there is any.

The system will then ask for the resource data of this order to be typed in which is:

- Resource number;
- Resource quantity;
- Resource unit price (if it is different to that estimated).

The Resource Data file must be entered in the system through either "Data Preparation" option (as explained in Chapter five), or accessed from the Estimating or Valuation System, and "PLUS COST" will check the resource number entered by this option if it already exists in the Resource Data file.

Again the system will show the entered data with the same

options: to amend, to file or to exit.

iii) *Editing Deliveries*

PLUS COST will prompt the user through this option to enter the following data about the deliveries:

- Order number (this must be entered through previous option);
- Date of last delivery;
- Resource number (this must exist in Resource Data file);
- Quantity of this delivery;
- Delivery note number.

The system will show the entered data with the same three options: to amend, to file or to exit to the previous menu.

The above first three options of " Material Control" function are the only options in this function which ask the user to supply data or update continuously and the data is required to be entered in the same sequence as those options in the Material Control function, because data in each option usually depends on the data entered in the previous one.

iv) *Determine Fixed Material*

This option has been added to this function to carry out all to-date calculations of the material used on site including wasted material from which all the information about the material usage and utilization on site can be gained as well as the actual cost of the material used weekly.

If this option has been selected. This will offer a set of options:

- a) Edit to-date material usage;
- b) View weekly material usage;
- c) View monthly material usage.

a) Editing Weekly Material Usage

"PLUS COST" will give access to the user to enter the weekly usage data of each material resource (which already exists in the "Resource Data File" . This data is:

- Related Cost Center code number;
- Measured quantity for valuation (quantity used to-date);
- Unfixed quantity on site;
- Other uses of this material resource (temporary work, etc.).

The data will be shown on the screen with the options: to amend, to file or to exit.

b) View Weekly Material Usage Reports

This option provides on-screen reports of weekly material usage for a selected week number (which is supposed to be entered in through the previous option), according to the data entered in the previous option. These reports will give details of the quantities used for each material resource at each cost center to be compared against the estimated figures.

c) View Monthly Material Usage Reports

"PLUS COST" will add the material usage data of those weeks in the selected month to show it as on-screen reports. These reports, as in those above, are used to check the estimated figures monthly.

v) *Margins On Deliveries Reports*

"PLUS COST" will ask the user through this option to type in all the resource numbers (which exist in Resource Data file) he wants to know about, and the system will do all the calculations to view a full detailed report showing the margins on the deliveries, up to the date, of these selected resources. These reports will show the margins in the selected material resources (as debit or credit) comparing with the estimate. The reports will be used as control reports on the material delivery to control the price variances.

The information in these reports is similar to that obtained from the "Material Fluctuation Claim Sheet".

These reports can be weekly, fortnightly or even monthly with the option of daily updating.

vi) *Margins on Orders Reports*

This option in "Material Control" function provides detailed and updated information of selected resource numbers (as explained in the previous option) as on-screen reports. These reports show the difference in the quantity and

the rates of each material resource between the estimates and the orders. This will give an indication if the project is in credit or debit from ordering this material. The reports can be used as feedback to the estimator who estimated the material rate figures. The reports also assist in making better orders by using the estimated rates as the upper price limits for these order prices. These reports can be weekly, fortnightly or even monthly and updated automatically along with the information in the updated "Order Data File".

vii) View Material Summary Reports

This option provides updated view reports of the material resources which have been used in executing the project with details on the estimated quantities, ordered quantities and quantities delivered for each of the resources. These details are essential in providing feedback reports to the estimator as well as giving a good impression to the user about the material delivery procedures on site comparing with the orders and estimates.

viii) View Order Summary Reports

This option provides the user with on-screen reports of the orders which have been made to date as a summary, and the amount of each order, to give an idea of the money required to be reserved for these orders and these reports can be used as documents for delivery due dates.

ix) View Supplier Account Reports

This option in the "Material Control" function will provide the user with a view report of the supplier accounts to date according to their deliveries. These reports are essential documents for the Accounting Department to keep the ledger revised all the time.

x) View Material Utilization Reports

One of the main objects of having the "Material Control" function in PLUS COST is to indicate and control the material utilization (performance) on site. This option in the system will do all the calculations to provide the user with up to date view reports which show the actual utilization of any selected material resources in percentages, compared with the Estimated Allowances, and then the losses or gains from that comparison in quantities and expenses. The reports give the rate of usage of the material and this assists in preventing high piles of that material resource (which may have a low rate of usage on site) being left on site. This is very important, especially when using expensive material. The materials with low utilization will be shown in these reports.

xi) View Material Wastage

The wastage of material is also another main object for carrying out material control on site. "PLUS COST" through this option provides weekly, fully detailed view reports which show the use of the material resources on site in that selected week and the wastage percentage of each resource with

its estimator wastage allowance percentage. The system's remarks are shown at the end of the reports from the comparison between the two percentages. So that the required actions may be taken on site, if the remarks show that the wastage of any resource on site for that selected week was over the estimated allowance.

The data entry of "Material Control on Site" function with its on-screen reports are shown in detail in Appendix J, figures (1-17).

6.5) SUMMARY AND CONCLUSION

From what has been explained before, the following points have been identified as a summary and conclusion of the work in this chapter.

1. The success of any project is dependent upon effective management of the available resources that are standards of cost by which the project must be controlled.
2. As far as control is concerned, contractors divided up their cost into: labour, plant, material and subcontractors, when other site costs are usually considered as overheads with no attention to the preliminaries as one of the standards.
3. "PLUS COST" deals with site costs in controlling the project under up to five headings of labour, plant, material, subcontractor and preliminary as standards of site cost which can be allocated and calculated on site by using different site sheets.

4. Both manual systems (Timekeeper and Ledger) have been considered in developing "Labour Control" function in "PLUS COST" by making "PLUS COST" applicable to both types of projects; Building and Civil Engineering.
5. By using "PLUS COST" on site, all the clerical work of filling in the site sheets used in these two manual systems can be achieved quicker and more accurately with no need for staff work on these systems, when "PLUS COST" will do all the calculations required to produce weekly labour basic costs on site as well as the labour control reports.
6. "PLUS COST" is the first system, amongst the other computer-aided site management systems, that has considered all the other labour costs on site which are bonuses (if they are operating) and on-cost overheads, by having an option for each within the system. These two other costs will be added to the labour basic costs to produce the actual gross labour cost on site.
7. From understanding the difficulty of allocating and controlling plant resource costs on site as they are dependent upon the nature of the project as well as the plant acquisition, size, and consumption. These factors have affected the efficiency of the available site management software. "PLUS COST" has been developed to consider all the above factors in achieving the "Plant Control on Site" function, by putting six points to be considered, by the user, before using this facility, and making the data required to be entered as general, by including all the expected costs on site such as the operating (running) cost and extra cost (any other

plant costs on site).

8. "PLUS COST" can control through this function both plant cost and performance and provides on-screen weekly reports of plant cost and utilization (performance). The other site management software usually cost the plant usage without considering its performance in controlling the site.
9. "PLUS COST" has a "Material Control on Site" function as a list of options, through which "PLUS COST" has achieved full coverage of the material usage on site by letting all the data about suppliers, orders, deliveries, material fixed and unfixed on site to be entered. This data will be used to provide (on-screen and print out) control and utilization reports.
10. Through these resource control functions (Labour, Plant and Material), "PLUS COST" can achieve both the project control on site as a whole as well as its resources usage and performance. This has made the control procedures more effective in indicating an efficient working area down to the fourth level of site organization (foreman level).
11. All the data entered is stored in an updated form in data files in "PLUS COST", ready to be used whenever required. "PLUS COST" is applied here as a documentary system which has the ability to store all the site data entered from the site sheets till the project finishes.
12. The options provided in each resource control function enable "PLUS COST" to cover any site conditions in controlling the resources and as an effective site control system, despite the control system being used on the site previously.

13. The on-screen reports in each resource control function have been designed to be presented similar to the control forms that are used in the manual control systems to make them easily understood. Also these reports can indicate the losing area and the bad performance more efficiently. The system remarks have been added to these reports to assist in indicating the loss making area and the bad performance.

At the end of this chapter and from the above conclusion, I have undertaken another step in achieving the "Business Requirements" specification of developing an efficient site management system by developing "PLUS COST" . By being as comprehensive, general and efficient as described above in costing and controlling the cost and the performance of the project resources (labour, plant and material). "PLUS COST" is expected to be the most efficient and effective computer-aided resource control and management system.

CHAPTER SEVEN

CHAPTER SEVEN

SUBCONTRACTOR CONTROL ON SITE

7.1) INTRODUCTION

It is now quite common for the main Contractor on a building/civil engineering project to carry out only a small proportion of the work directly (ref.109). Subcontractors are used for the major part of most work but sometimes the involvement of the main Contractor may be nil, in coordinating for the client, the services of the various subcontractors. In these circumstances the methods used become increasingly important.

There are considerable difficulties facing the Main Contractor in combining the efforts of a collection of subcontractors each intent on progressing their own section of the work (ref. 116). His difficulties are often increased by a lack of detailed knowledge of subcontract operations and even in many cases, by an insufficiently systematic approach to subcontract management.

The absence of any direct financial risk to the Main Contractor where Subcontractors are concerned can obscure the indirect risk involved. Heavy losses can occur through delay and disruption if subcontract work is allowed to proceed without adequate control.

This chapter highlights the methods of controlling the subcontractors on site and then shows how "PLUS COST" as a site

control model can assist the contractors is controlling the Subcontractors cost on site by using the same site sheets as in the manual system, but in a more efficient and faster method by using a computer-aided site management system.

At the beginning, the chapter explains the Subcontractor definitions and types, the manual system for controlling the Subcontractors on site which is in use and its site data sheets and practices that might appear on the site influencing the Subcontractor control on site. It explains then how a computer-aided site management system "PLUS COST" can provide a better and more efficient Subcontractor site control system by using the same site data as in the manual system more efficiently.

7.2) SUBCONTRACT-DEFINITIONS AND TYPES ON SITE

A subcontract is defined as (ref. 121); "an agreement between the prime Contractor and another Contractor or supplier for a satisfactory performance of services or delivery of material as indicated on the plans and specification, all as evidenced by the contract documents".

A Subcontractor may be defined as (refs. 109 & 121); "a secondary Contractor who performs some part of the prime Contractor's obligation under the contract". There can be several levels of subcontracting.

Two types of Subcontractors can be quoted, 'Nominated Subcontractor' who is nominated by the client and named in the

contract with the main contract, and 'Domestic Subcontractor', who is employed by the Main Contractor to do part of his work. Both types of Subcontractors, in turn, may engage other Subcontractors. Subcontractors can also be quoted according their work into; Labour only, Labour and Material or Labour, Plant and Material Subcontractors.

There are typical work items which are usually subcontracted to a specialty Contractor by most general Contractors (ref. 109). And those specialty Subcontractors may engage other Subcontractors to assist them in executing these work items or providing the material for them.

7.3) SUBCONTRACTORS CONTROL ON SITE MANUALLY

The responsibility for controlling and reporting the costs of Subcontractors usually lies with the contractor's quantity surveyor.

The overall control of Subcontractors may differ according to the type of Contractors themselves (e.g. labour-only or labour and material). For labour-only subcontractors, the most important factor is the attendance factor which is used to control the attendance of the Subcontractor's labourers. Whilst for labour and material Subcontractors, the most important is what is called sub-letting margins (the margins in the value of the subcontract in the tender over the actual cost), as well as their monthly liabilities.

To predict the likely difficulties and conflicts, the reliable measurement of progress and to obtain maximum participation and performance from each Subcontractor, the Contractor may call upon the services of the Subcontractors representatives (e.g. Subcontractor coordinator, advisory team, management and planning staff etc.), to discuss their work progress and if there are any difficulties in the work that may need resolving.

Control is obtained by measuring progress against the pre-set targets from the programmes (set up in the pre-contract stage), and extrapolating trends of probable future events (an efficient record system may also be based on this procedure) (ref. 116). The most important requirement in measuring and reporting is the speed, since any remedial action must be decided upon and put into practice as quickly as possible to minimize delay to the Contractor. Measurement, therefore, should be only as accurate as is necessary for the production of useful reports.

Where the work of a Subcontractor is being measured by the Contractor's quantity surveyor, the Subcontractor's own assessment of his progress should be obtained and taken into account, and should also include all unpaid measurements (such as claims or variation orders).

Monitoring will cover not only simple progress, but also the situation relating to design work, information supply, the adequacy of labour and materials and the prediction of the future

trend of events.

However, two types of control are required for Subcontractor control on site; first, weekly or fortnightly (short term), secondly, monthly or five weekly (medium term).

7.3.1) Weekly Control

With labour-only Subcontractors, particularly, the Main Contractor should not only be concerned with traditional items (i.e. dayworks, services, wastage/abuse), but he is also monitoring subcontractors labourers productivity and absenteeism, by weekly payment or letting margin reports, figure (7.1), from which the productivity, absenteeism and wastage of material can be monitored as a Short Term Control. By doing that, the Main Contractor can ensure that he is getting value for the money he paid.

7.3.2) Monthly/Five-Weekly Control

For medium term control and monitoring of Subcontractors as well as predicting the likely difficulties or conflicts, a monthly or fortnightly liability sheet is filled in by the contractor's quantity surveyor at the time of interim payments, figure (7.2), giving the Contractor's internal valuation on the agreed retention, the certified payment to Subcontractor and any claims or variation order amounts raised by the Contractors. From these liabilities the Contractor would be able to predict the profits or losses on Subcontractors as well as the money which has not yet been paid to the Subcontractors.

<u>ANY CONTRACT & SONS LTD.</u>		<u>CONTRACT</u>	
<u>SUB-CONTRACTORS LETTING MARGINS</u>			
TYPE OF THE WORK	VALUE OF SUBCONTRACT IN TENDER	ACTUAL SUBCONTRACT	LOSS £
Structural Steelwork	23540	23540	---
Plumber	10961	10400	---
Felt Rooter	4210	4530	320
Painter	1083	1083	---
Fencer	846	813	---
		594	---
		320	---
		274	---
		<u>Overall Letting Margin</u>	---

FIGURE (7.1); THE CALCULATION OF LETTING MARGINS ON SUB-CONTRACTORS

ACCOUNTING PERIOD									
CONTRACT NUMBER									
CONTRACT TITLE									
SUB-CONTRACTORS LIABILITY SUMMARY (SLS)									
SUM IN CON-TRACTORS INT. VAL	GROSS CERT TO SUBCONT	NET AMT. CERT. TO SUBCONT	FURTHER LIAB.	TOTAL SUBCON LIABILITY	PROFIT/LOSS ON SUBCONT.	TOTAL SUBCONT RETENTION	CLAIMS AGAINST S/C	CLAIMS FROM S/C	LIABILITIES TO SUBCON.

FIGURE 7.2; THE SUB-CONTRACTOR LIABILITY SUMMARY FORM (SLS)

For supporting this form, the Contractor must have a full record of claims and variation orders which are raised by his Subcontractors with all the details, the same as the details in his own record concerning claims and variation orders which are raised by him on the client.

These two forms must be filled up accurately because they will then be used to produce monthly accounting reports which show the entitled payment of the Subcontractors including claims and variation orders.

7.4) THE SUBCONTRACTOR'S SITE ADJUSTMENT

In addition to the basic actual site cost of executing the project according to the BoQ items, the Subcontractor may find unexpected practices on the site. These site practices affecting the actual cost of the subcontract, and producing extra money which will be either added to or subtracted from the agreed amount of the subcontract. Each of the site practices such as; claims, variation orders, daywork and price fluctuation, has a different influence on the actual subcontract figures. This influence affects the efficiency of the Subcontractor control system on site. None of the available site management systems has considered these practices in controlling the Subcontractors on site. PLUS COST has been developed, for the first time, to include these practices in its controlling of the subcontractors.

The details of dealing with these practices are the same as explained in chapter nine, of dealing with practices of a similar nature that are achieved by the Main Contractor.

In controlling these practices, I have developed PLUS COST to control the claims and variation orders separately from those of the Main Contractor (as explained later in this chapter), while the other practices (daywork and price fluctuations) are controlled as part of the Main Contractor practices (as explained in chapter nine).

7.4.1) Subcontractor's Claims

Claims can be raised by the Subcontractor which may well pose problems for the Contractor. Resolution of the claim will cost the Contractor time and money and a major claim could result in the necessity for legal advice and arbitration. The cost of resolution can, therefore, be expensive in addition to the sum that is being claimed, and due provision must be made. Subcontractors claims can be part of the Contractors claims or separate claims on the Contractor. In both cases, the Contractor often takes the view that Subcontractors claims run in tandem with their own claims and that when such claims are resolved, then automatically the subcontractors claims can be solved to the subcontractors satisfaction.

The details of dealing with Subcontractor's claims is the same, as explained in chapter nine, of dealing with claims of the Main Contractors.

7.4.2) Subcontractor's Variation Orders

The subcontract work may be varied and a situation may exist where the contractor is negotiating with the Subcontractor on the value and effect of variations. The details of dealing with variation orders are the same as explained in chapter nine later, for variation orders of the Main Contractor.

So a good and efficient control system on subcontractors requires good recording of the claims and variation orders the same as for the Main Contractor.

7.5) EFFECTIVENESS OF SUBCONTRACTOR CONTROL

From what has been said before, certain fundamental principles governing the effectiveness of a site control system for subcontractors were identified as:

- a) the degree of control exercised over a Subcontractor should be related, by some convenient means, to the amount of damage to the Contractor likely to result from his failure to perform adequately;
- b) the influences of progress control, minimum weekly control record systems and day-to-day management by the Contractor must be unified by the total system;
- c) for controlling the contractor's payments and monitoring the money losing areas, a good weekly or fortnightly recording system must exist which shows the attendance of subcontractors labourers (for labour-only Subcontractors), as well as monthly or five-weekly

- recording systems required to show the summary of subcontractors liabilities as agreed;
- d) human relations remain the most important factor governing the success of control. By convincing the subcontracting staff of the soundness and fairness of the procedures used, the system will have the effect of inducing them to take action;
 - e) the simpler the system, the more likely it is to succeed.

7.6) SITE CONTROL OF SUBCONTRACTOR BY USING "PLUS COST"

Through the first option of the system (Data Preparation), all the general data about the subcontractors as explained in chapter five, should be entered and stored in "Subcontractor Data File" to be used through this function (Subcontractor Control on Site). In this function, "PLUS COST" has been developed to achieve what has been highlighted through this chapter, bearing in mind the effectiveness requirements. It has been designed to control the subcontractors cost and performance on site function. In this function "PLUS COST" behaves as a separate control system, has its own filing system and its own claims and variation orders from the main system. So that through this function, "PLUS COST" deals with subcontractors as "Contractor" to the actual Main Contractor as well as one of the resources of the BoQ item rates.

Through "Subcontractors Control on Site" function, "PLUS COST"

has been developed to achieve the following facilities:

- 1) calculate the subcontractors costs for the work done on a weekly/monthly basis, and these costs can be added to the other costs (e.g. labour, plant, etc.) to get the actual costs of the work done on a weekly/monthly basis from which the required comparison reports can be obtained as system print-outs for monitoring and control purposes.
- 2) indicate the Subcontractor performance weekly from comparing the actual cost calculated in the above point against the estimated value of the work he has executed to produce the letting margins reports.
- 3) provide good documentary files of the Subcontractors claims and variation orders, as well as their expenses, which can then be used for predicting any likely damages or conflicts with the Subcontractors.

Figure (7.3) shows, in flow chart form, the above necessities as well as the internal procedures of this function in "PLUS COST".

Use of this function in "PLUS COST" offers seven further options:

- i. Edit weekly payment sheets;
- ii. Edit monthly liability summary;
- iii. Register and/or measure the claims;
- iv. Calculate the variation orders;
- v. View weekly letting margins;
- vi. View monthly liability summary;
- vii. View monthly accounting reports.

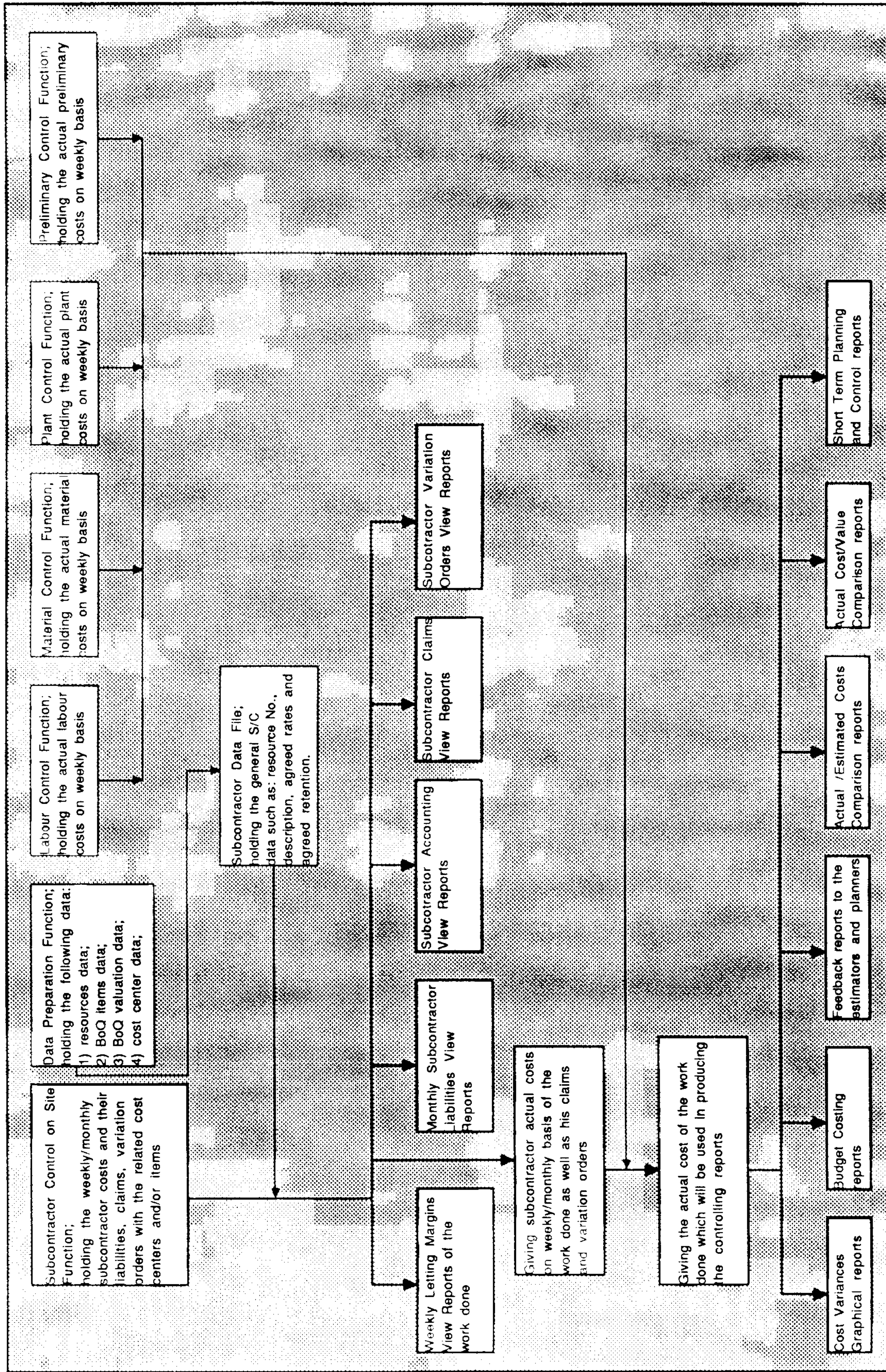


FIGURE (7.3); THE "PLUS COST" INSIDE PROCEDURE NETWORK OF THE "SUBCONTRACTOR CONTROL ON-SITE" FUNCTION

i) *Editing Weekly Payment Sheets*

This option has been added to the Subcontractor Control function in the case where Labour-only subcontractors have been used on site, although it can be used by the Contractor to get short term control on the subcontractors (weekly control).

Through this option, "PLUS COST" will ask for the following weekly data of each subcontractor code number to be entered by a set of interactive questions shown on the screen. The data is:

- related item code;
- this week's payment;
- quantity executed (as units).

After all the data has been typed in, "PLUS COST" also has the facility of re-showing any of these interactive questions again on the screen if the answer was illogical. The system lists all the entered data with the options; to amend, to file, to exit, to give another chance for any amendment before the data is filed.

ii) *Editing Monthly Liability Summary*

Also by a set of interactive questions, "PLUS COST" will allow the user to enter all the Subcontractor liabilities which are incurred through each interim payment for the purpose of medium term control (monthly control). The data is as shown in the Subcontractors Liability Summary Form, figure (7.2).

And again, after all the data is entered with an answer of 'no more data required to be entered', "PLUS COST" will show all the entered data with the same options; to amend, to file, to exit.

iii) *Claims Registration and Measurement*

Subcontractors claims on the Main Contractor are usually considered by the Main Contractor to be as important as the claims raised by himself and they can be part of his claims. This facility (Control of Subcontractor Claims on Site), has been developed in "PLUS COST" to have the same options as in the "Claims Control" facility for the Main Contractor which is explained in chapter nine with the following modifications:

- 1) in editing claims measurement, the Contractor will be interested in the amount of the claim resources despite the details of each resource in the contract.
- 2) in viewing the individual or total claims summary, the same point in (1) above has been considered.

So that, through this facility, the Contractor will have a good documentary system of his subcontractors claims as well as his own claims and these documents will assist in solving the claim problems, either raised by the subcontractors or by himself.

iv) *Variation Orders Calculation*

This facility in the "Subcontractor Control"

function has been designed to be similar to that for the main contractors. The data for these variation orders will be filed separately from the other variation orders for the Main Contractor, to be used in calculating the subcontractors cost.

Chapter nine explains the method of using "Variation Orders Control" for Main Contractor which is similar to this as previously mentioned.

v) *View Weekly Letting Margins*

Through this option, "PLUS COST" can provide weekly reports for any selected week, which show, the value of the work executed by the Subcontractor through the week, the payments to be paid to the Subcontractors, the variances between the two and the remarks on these variances, if the Contractor is gaining or losing money in that selected week. From these weekly reports, the Contractor achieves short term control on the Subcontractors, especially "Labour-only Subcontractors", by monitoring their productivity, absenteeism and wastage of material weekly.

vi) *View Monthly Liability Summary*

"PLUS COST" also does all the required calculations to provide "Monthly Liability Summary" reports for any selected month which show, for each subcontractor's code number, the incurred Subcontractor liabilities, on the Main Contractor, such as the value of the work done as priced in BoQ items, the entitled payments as in the certificates less the

agreed retentions, the claims accepted and the variation orders liabilities.

These reports will assist the Contractor in controlling, at each interim payments time, the Subcontractor liabilities, which are required to be paid by the Contractor.

vii) View Monthly Subcontractors Accounting Reports

From the previous two control reports, "PLUS COST" through this option, does the calculations to view brief reports for accounting purposes. The reports show, for each Subcontractor number, the value of the work done as priced in the BoQ items, the amount certified from the liabilities and the variances between the two figures. The system will give its remarks, at the end of the reports, to show if the Contractor gained or lost these variances through this subcontract. These reports are essential for the Contractor's Quantity Surveyor to check the payments to the Subcontractor according to the work executed by him.

The data entry and the on-screen reports of the "Subcontractor Control on Site" function are shown in detail in Appendix K, figures (1-16).

7.7) SUMMARY AND CONCLUSION

From what has been explained in this chapter about the control of the Subcontractor on site, the following points can be identified as a summary and conclusion.

- 1 - It is quite usual these days for contractors on building/civil engineering projects to carry out only a small proportion of the work directly. When subcontractors are used for the major part of the work, the involvement of the Main Contractor may be virtually nil, so that good consideration is required to be taken of Subcontractor control on site in any site control system.
- 2 - The difficulties of controlling Subcontractors on site are often increased by a lack of detailed knowledge of Subcontractor operations or by an insufficient systematic approach to subcontract management.
- 3- There are usually two types of subcontractors, Nominated and Domestic, the first one nominated by the client, whilst the second one is employed by the Contractor himself, but both under the responsibility of the Main Contractor. There are three types of subcontractors, according to the work they do, Labour-only, Labour and Material and Labour, Plant and Material Subcontractors.
- 4 - In controlling the subcontractors manually on site, the most important factor for a Labour-only Subcontractor is the attendance of the Subcontractor labourers, whilst for Labour and Material, it is the margins in the value of the Subcontractor over the actual cost, as well as the monthly liabilities.
- 5 - Two types of Subcontractor control are usually used on site, according to the time term, either "Short Term" control, which is weekly or fortnightly or "Medium Term" control which is monthly or five-weekly.

- 6 - The subcontractor's control is an important factor which could cause damages to the contractor's performance and profit. So I have developed Subcontractor Control function in "PLUS COST" to provide two facilities. Firstly controlling their cost as one of the project resources like labour, plant etc. Secondly holding and providing all the documents of subcontractors claims and variation orders as well as their expenses. From these two facilities, the Contractor through this function can control the cost of the subcontractors as well as their performance.
- 7 - By using "PLUS COST", the Contractor in controlling his Subcontractors can use either a "Short Term" or "Medium Term" controlling system by editing weekly or monthly site sheets.
- 8 - From these sheets, "PLUS COST" can provide reports on weekly letting margins, monthly liability summary and monthly accounting reports as well as the reports for claims and variation orders. These reports have provided a full coverage of the Contractor's requirements in controlling his Subcontractors on site efficiently.
- 9 - Also through Subcontractor Control on Site function, the user has been provided with an efficient control system on the Subcontractor's claim and variation orders. They have data files separate from these for the Main Contractor.
- 10 - In entering the site data through this function, "PLUS COST" has a set of interactive questions that are similar to what is required in the control site sheet manually, to make using this facility easy and similar to the way of dealing

with the data in the manual system.

11-In addition to that, this function has two ways of correcting the mistakes in the data entered, either by re-showing the question on the screen if the answer was not logical or by giving an option to amend the data after each time a set of data is entered and before the data is filed.

12-All the view reports have been designed to be presented by "PLUS COST" through this function similar to those reports used on site by the manual control systems. These reports will give a clear identification of the problem area in the Subcontractors work in a very short time and while the work is in progress.

At the end of the chapter and from the work done through it. I have achieved the required efficient and effective control on the Subcontractor on site. In this control " PLUS COST" calculates the cost and liabilities of the subcontractors in minutes from entering the site data and by considering the adjustment of the site practices. It also controls the performance by comparing the actual cost against the estimate and produces the weekly letting margins. Furthermore, "PLUS COST" operating as a documentary system holds and provides all the data about the Subcontractor's claims and variation orders documents, to be used whenever required, so that any conflict can be predicted and resolved before it can damage the work's progress.

These three features of Subcontractors Control function have made the system the most efficient system used on site in controlling the Subcontractors work.

CHAPTER EIGHT

CHAPTER EIGHT

PRELIMINARY CONTROL ON SITE

8.1) INTRODUCTION

Site overheads or the contract preliminaries are usually described as those items of an organization of a general nature which affect the cost of work, but which are not restricted to any particular work section. These items usually have a separate section within the bill of quantities (ref. 92).

The importance of considering preliminaries in the site control systems comes from the idea that it is difficult to work out the true value of preliminary items. The professional surveyor often turns to the most convenient and expedient form of valuing preliminaries, rather than attempting to make a valuation according to the expenditure pattern (ref. 124).

Methods employed by a professional quantity surveyor in valuing preliminaries for an interim payment often do not reflect the true pattern and that will lead to problems in the control of preliminaries expenditure and revenue for accurate financial reporting on a contract.

In the survey on the construction company systems as well as the software available in the market, it was found there is still no consideration in controlling the preliminaries in their systems (as

explained in chapter two) because of the above problems. That has made these systems behind still in fulfilling the promise of having an efficient site management systems.

This chapter explains the manual methods used to value and control the preliminaries on site, the problems associated with these methods and how "PLUS COST" as a computer-aided site management model has fulfilled the promise and assisted in controlling the preliminaries on site by solving these site control problems efficiently.

8.2) VALUATION OF PRELIMINARIES

The valuation of preliminaries tends to be a problem area, many of the difficulties being due to the way in which the contractors price this section of the BoQ before the tender is adjudicated. If additions are made at the adjudication stage, that may cause problems with monies paid as preliminaries which probably belong to unit rates for work that may or may not have been done at the time of the interim valuation (ref. 92).

The other problems include the way in which the quantity surveyor agrees payment. If the quantity surveyor averages the payments for preliminaries globally on a time basis, that could possibly make the contract over or under recovering of the amount of preliminaries due, especially if the contract is behind schedule. In this situation the quantity surveyor may allocate payments in proportion to the progress of the work.

However, there are three types of preliminaries valuation in use (ref. 74), based on:

- 1 - The amount of the contract period that has elapsed, sometimes called the "Time Related Method" in which the Contractor estimates the payments on a weekly basis at a rate calculated from dividing the value of the preliminaries bill by the contract period to give a rate of (£/week).
- 2- The value of the work done is sometimes called "Cost Related Method". By this method the amount included in an interim valuation is at the rate calculated from dividing the total value of the contract by the total value of preliminaries.
- 3- The Completion of the contract is called "Lump Sum Method", such as; insurance, cleaning and drying out.

Each method has some disadvantages. Under the first two methods any provisional sums included in the preliminaries must be deducted prior to the calculation, also the first method fails to take account of the fact that the work may not be on target. Moreover, the first two methods do not deal effectively with lump sums, while the third one is very simple and cannot be used to indicate the usage of the preliminaries while the contract is executed.

Therefore, a mixed method has been developed in "PLUS COST" to make valuation of preliminaries more realistic and accurate by dealing with each preliminary item separately to suit its

particular circumstances. This method is supposed to be used by the Estimator in calculating the estimated payments of preliminary items in the bill of quantities.

8.3) PRELIMINARY CONTROL ON SITE MANUALLY

Control of the preliminary expenditure and revenue is of particular importance for accurate financial reporting on a contract. The contractors could lose a lot of money without being able to identify the reasons behind it if they don't have a good control system on the preliminary expenditure on site, as found in my research survey on the construction companies.

Different methods can be used to obtain this control depending on whether preliminaries are priced solely in the preliminary bill item or whether they are partially or totally spread in the bill rates (ref. 92).

8.3.1) Priced Totally in Preliminary Bill Items

Control of this type is usually carried out by referring to the contract bar chart (figure 8.1) and the tender build up of the preliminaries by the Estimator. It is relatively simple to construct a Preliminary Budget (PB), as shown in figure (8.2). This budget represents the planned way in which the preliminaries would be spent over the contract. The actual costs incurred can be monitored against it and losses or gains against the budget sum are shown by the preliminary monthly/weekly reports and/or monthly analysis site reports.

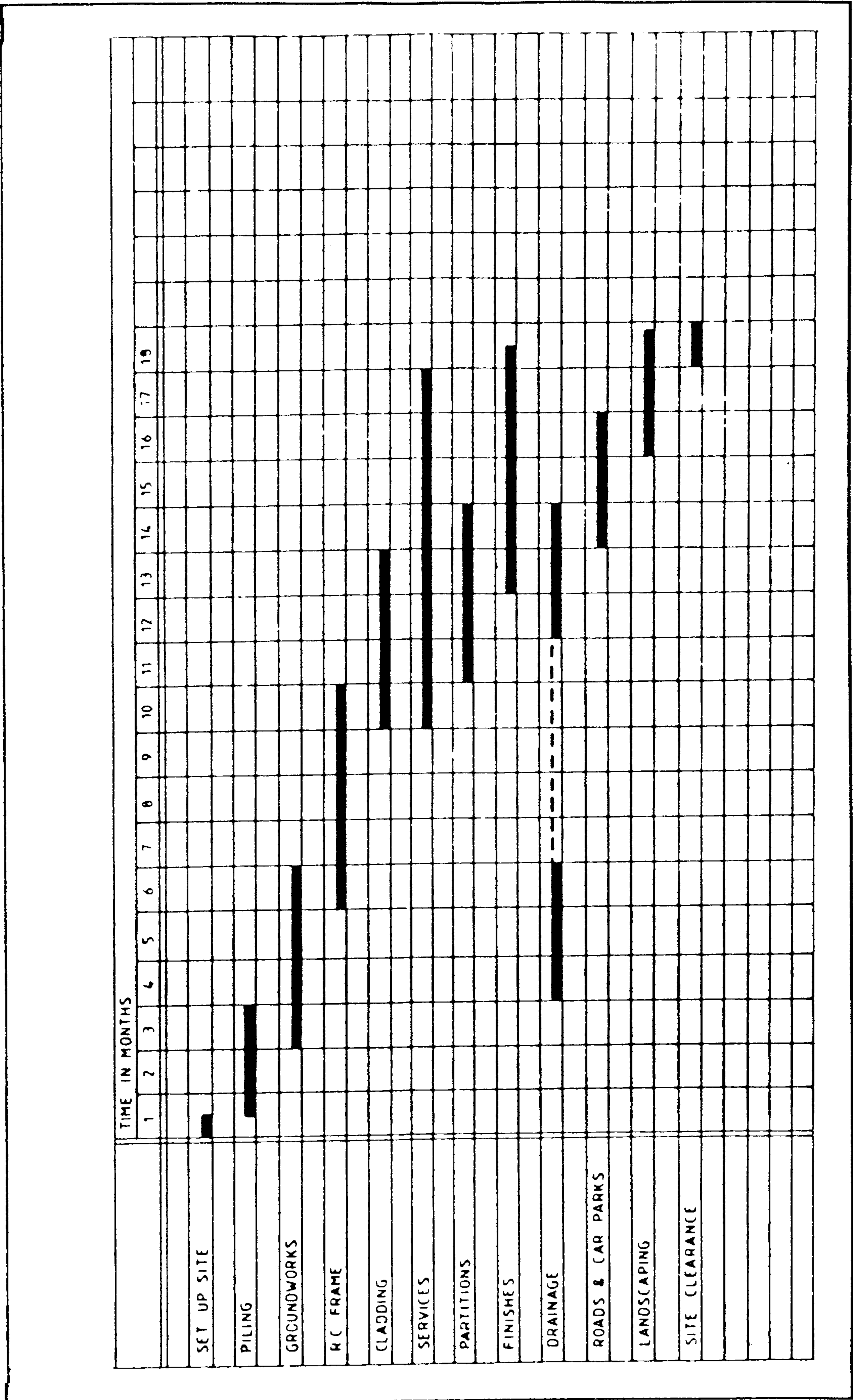


FIGURE (8.1); A SAMPLE OF THE CONTRACT PROGRAMME IN A BAR CHART FORM

	TIME IN MONTHS																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1 PLANT HIRE																			
2 FUEL & CONSUMABLES																			
3 SMALL TOOLS																			
4 SITE VEHICLES																			
5 TRANSPORT																			
6 HUTTING																			
7 ELECTRICITY/WATER																			
8 ATTENDANT LABOUR																			
9 MISC MATERIALS																			
10 STAFF																			
11 DESIGN / TEMP WORKS																			
PRELIMINARIES																			
CUMULATIVE PRELIM.																			

FIGURE (8.2); A SAMPLE OF PRELIMINARY BUDGET (PB) IN A BAR CHART FORM

The actual costs can be collected weekly either from the site via the weekly site sheets or from the Head Office, such as consumption of fuels, oils etc.

8.3.2) Priced Totally or partially in The Rates

The preliminary money is distributed throughout the rates in the bill of quantities, either as a result of tender adjudication or as a deliberate pricing policy as shown in figure (8.3). This distribution must be associated with a detailed examination of the tenders to identify where any money has been taken from preliminaries and distributed elsewhere in the bills. The distribution might happen, for example, if it has been decided at the adjudicating stage to reduce the amount of labour in the tender but as the bill rates had already been written up and cannot be altered, the adjustment is made to the preliminaries.

As a result, the preliminaries revenue will be obtained as the relevant works are carried out and not as part of the general preliminaries. The Contractor must recognize such money as belonging to preliminaries and a reconciliation must be made of money earned directly as preliminaries and money which are preliminaries but earned as part of the rates for executing the works. A simple control form called "Preliminary Calculation Sheet", figure (8.4), is used to show the preliminaries amount allocated within rates contained in the bills and the amount of preliminary items, both values will be added together to be compared against the actual cost to date for the reconciliation purposes, by using Preliminary Analysis Sheet, figure (8.5).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
REDUCED PRELIMINARIES	3700	3700	3700	2900	4000	2400	2600	3000	2600	4500	5000	4300	4400	4800	4400	3200	3800	3150	65650	
IN RATES																				
GROUNDWORKS																				5000
RC FRAME			1250	1250	1250	1250														10000
PARTITIONS						2000	2000	2000	2000	2000										15000
FINISHES											3750	3750	3750	3750						
															2000	2000	2000	2000	11000	
																				106650
	3700	3700	4450	4150	5250	5650	4600	5000	4600	6500	8750	8050	10150	10550	6400	5200	5800	4150		
		7400	11850	16000	21750	26900	31500	36500	41100	47600	56350	64400	74550	85100	91500	96700	102500	106650		

FIGURE (8.3) ; PRELIMINRY REALLOCATION WITHIN BILL RATES

Contract Title	Month Ending				Contract Number								
	Contract period		Present week	Contract Number									
	In prel.	In rates				Programming position							
Overall tender		Cumulative to date		Current period		External valuation		Reconciliation					
	A	B	C	D	E	F	G	H	J	K	L	M	N
	In prel.	In rates	Total	PR chart to date	Cost to date	Difference	PR chart this month	Cost in month	Difference	Cum. to date	Curr. month	Difference Col D/Col K (cum diff)	Difference Col G/Col L (month diff)
Plant hire													
Fuel and consumables													
Small tools													
Site vehicles													
Transport													
Hutting													
Electricity, GPO, Water													
Attendant labour													
Miscellaneous materials													
Staff													
Design													
Total													

FIGURE (8.4); THE PRELIMINARY CALCULATION SHEET

		Month Ending		Contract Number						
Contract period		Present week	Programming position		Contract Number					
PB Total	Cumulative to date			Current period		External valuation		Reconciliation		
	PB to date	Cost to date	Difference	PB this month	Cost this month	Difference	Cum. to date	This month	Diff. Col B/H cumm.	Diff. Col E/J curr.mth.
A	B	C	D	E	F	G	H	J	K	L
Plant hire										
Fuel and consumables										
Small tools										
Site vehicles										
Transport										
Hutting										
Electricity, GPO, Water										
Attendant labour										
Miscellaneous materials										
Staff										
Design										
Total										

FIGURE (8.5); THE PRELIMINARY ANALYSIS SHEET

8.4) PRELIMINARY CONTROL ON SITE BY USING "PLUS COST"

"PLUS COST", for the first time amongst the other site control systems, has been developed to have "Preliminary Control on Site" as a function in the system to control both types of the preliminaries on site (i.e. preliminary bill items and preliminary in-rates) and to achieve the following objects;

- 1 - to get like-to-like figures (i.e labour, plant, material, subcontractors and preliminaries) which are used in the build-up of the BoQ item rates, so that the comparison reports will have a similarity between the estimated figures and the actual figures. These comparison reports will give better feedback data to the Estimator as well as better understanding of the preliminary for future use, in case the Estimator didn't have the time to adjudicate the BoQ items at the adjudication stage.
- 2 - in addition to providing feedback reports to the Estimator and Planner on the project as a whole, this function also provides feedback reports to the Estimator on preliminary items, when all the operations are subcontracted and the feedback on preliminary items is only required, because at the tender stage, the cost of all the operations would have been agreed between the Main Contractor and the Subcontractor. By providing such a feedback facility, the Estimator is able to put in more competitive tenders.
- 3 - to cover most of the preliminaries incurred on site by dealing with both types of the preliminaries (i.e. in-rates

and as bill items) in two different ways to make the method of controlling and monitoring them reasonable and acceptably effective.

However, the control of each type of the preliminaries on site, by using "Preliminary Control on Site" function in PLUS COST is explained as following.

8.4.1) Control of Preliminary Bill Items

The preliminary bill items cannot usually be related to any bill item or cost center to be controlled by and at the same time have a remarkable effect on the control procedure of the project. "PLUS COST" deals with the preliminary bill items as a separate cost center and has separate data files other than those for the preliminary in-rate type.

After all the data has been entered, "PLUS COST" will do all the required calculations automatically to produce the preliminary actual cost to be used in producing the required project control and feedback print-out as well as on-screen reports of the preliminary control on site, as shown in figure (8.6).

To use this facility through "PLUS COST", the user has to select "Preliminary Control on Site" function from the system. Through this function, the user could work on:

- BoQ preliminary items;
- Preliminary in rates.

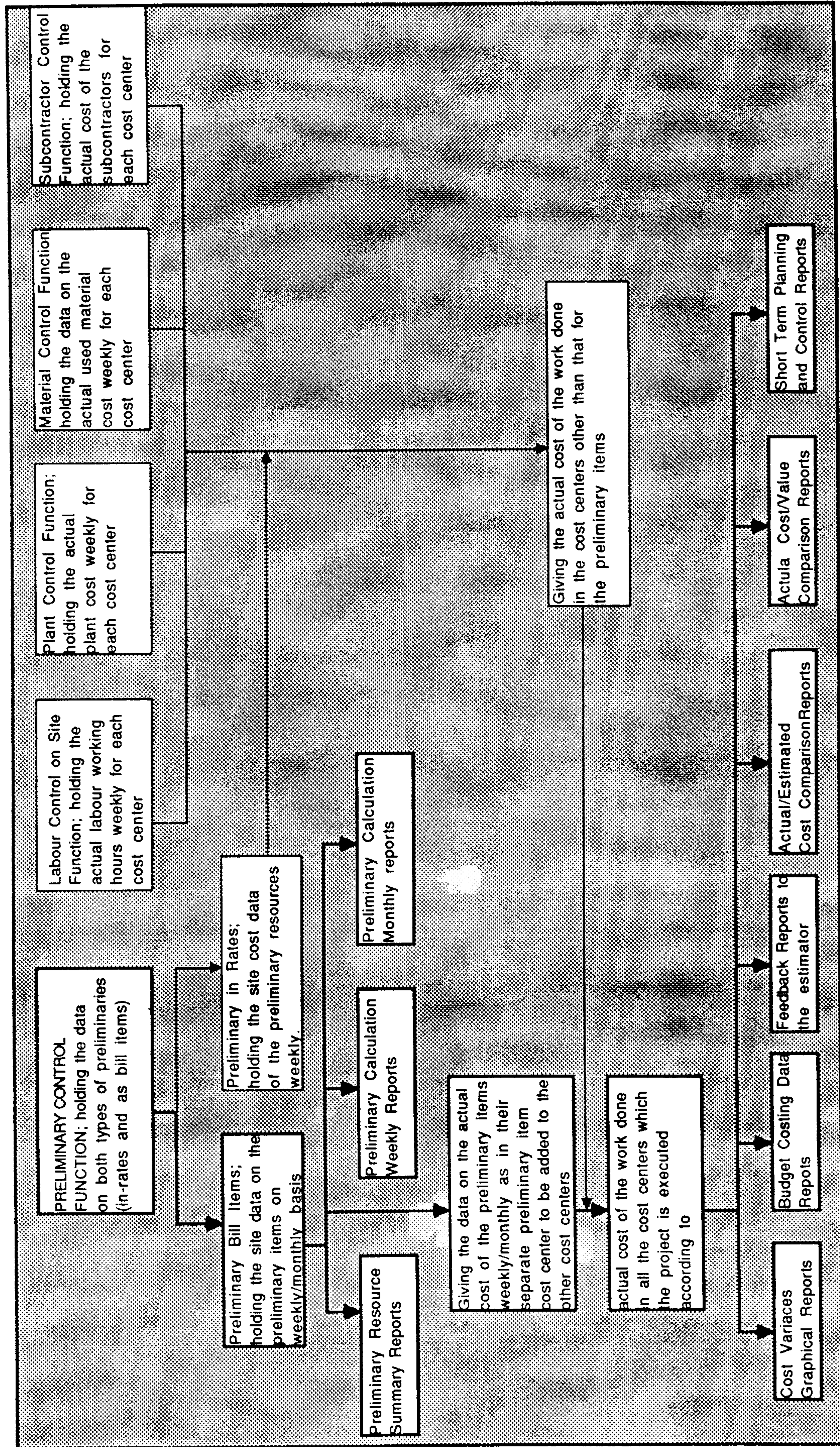


FIGURE (8.6); THE "PLUS COST" INSIDE PROCEDURE FOR THE "PRELIMINARY BILL ITEMS" FACILITY

And by selecting "BoQ Preliminary Items" option, the user can;

- i. Edit preliminary resource data;
- ii. Edit preliminary resource site data;
- iii. View preliminary calculation weekly reports;
- iv. View preliminary calculation monthly reports;
- v. View preliminary resource summary.

1) Editing Preliminary Resource Data

This option will ask for the following general data on the preliminary items to be entered by a set of interactive questions. The data is; preliminary code number, description, bill total. Also it will ask about the valuation type which is:

- * time related;
- * cost related;
- * lump sum, which includes:
 - initial lump sum;
 - recurring sum;
 - recurring period (in weeks).

After all the data has been entered with a final answer of "no more data to be entered", the system will display all the entered data with the options; to amend, to file or to exit.

A standard preliminary code list is required for each contract.

ii) *Editing Preliminary Resource Site Data*

This option gives access to the weekly site data of each preliminary item code number (must exist in the Preliminary Data File) to be entered. The data will be similar to that required to be filled in the "Weekly Site Sheet". The data is;

- * preliminary cost fractions; which are:
- * bonus cost;
- * labour cost;
- * plant cost.

On completion of this exercise, the user again has the option to amend, to file or to exit.

The reporting period of the data into the system depends on the recurring period of the preliminary: it could be one week, two or more. It is usually one week period.

iii) *View Preliminary Resource Summary*

This option will prompt the user to have on-screen reports of the preliminaries that are totally in the preliminary bill items and those which do not belong to any of the items or the cost center works, after they have been entered through "Editing Preliminary Resource Data" option and stored in the "Preliminary Items Data File". These reports give details for each preliminary code number on; its description, valuation type, bill total, initial lump sum and recurring period. Also these reports will give an indication for Lump Sum valuation type of preliminaries as this type of preliminary valuation cannot be

monitored until the completion of the contract. The Contractor uses these reports to get an idea about the cost of these preliminaries and the time period of each recurring preliminary.

iv) Preliminary Calculation Weekly Reports

Through this option, "PLUS COST" can provide view reports of the preliminary calculations of a selected week, which give details for each preliminary code number on its description, tender estimate total, tender estimate for this week, the actual cost from the site sheet and the system remarks according to the comparison between the tender estimate for this week and the actual site cost. The remarks will be either "UNDER/OVER RECOV.", if the preliminary is the Time Related valuation type, or "UNKNOWN", if the preliminary is the Cost Related type, (when the actual cost cannot be known till the interim monthly valuation) or Lump Sum, if the preliminary is the LUMP SUM valuation type (which can't be known till the completion of the contract). These reports are used for controlling the money spent on these preliminaries compared with the estimates, according to the method of calculating these reports.

v) View Preliminary Calculation Monthly Report

"PLUS COST" will provide through this option on-screen reports of the preliminary calculation for the current interim valuation month. They will have the same headings as in the previous option "Weekly Preliminary Calculation" with one difference. The difference is the remark for preliminary of Cost Related valuation type will be either

UNDER/OVER RECOV. instead of UNKNOWN, because the system can now calculate the monthly actual cost of this type of preliminary. These reports are used for the same purpose as the ones above, with the addition of showing the actual cost of Cost Related Preliminaries which could not be shown in the ones above.

8.4.2) Control of Preliminary In-Rates

In addition to the "Control of Preliminary Bill Items" facility provided by the function "Preliminary Control on Site". "PLUS COST" also provides the facility "Preliminary In-Rates Control" through this function. These preliminaries (as explained before in this chapter) are re-allocated from preliminaries bill items and distributed over the BoQ items as a result of adjudication of the tender or as deliberate pricing policy. Also included are the preliminaries which can be allocated to the cost center works.

PLUS COST will give an access to the weekly site cost to be entered manually and will then do all the calculations to produce the actual costs for the preliminaries. These costs will be distributed over the cost centers according to either; cost center dedications (as %), entered by the user or to the work executed in each cost center. The costs will then be added to the other resources costs (i.e. labour, plant, etc.) to produce the actual cost of the work done for each cost center which will be used in producing the controlling and feedback reports as shown in figure (8.7).

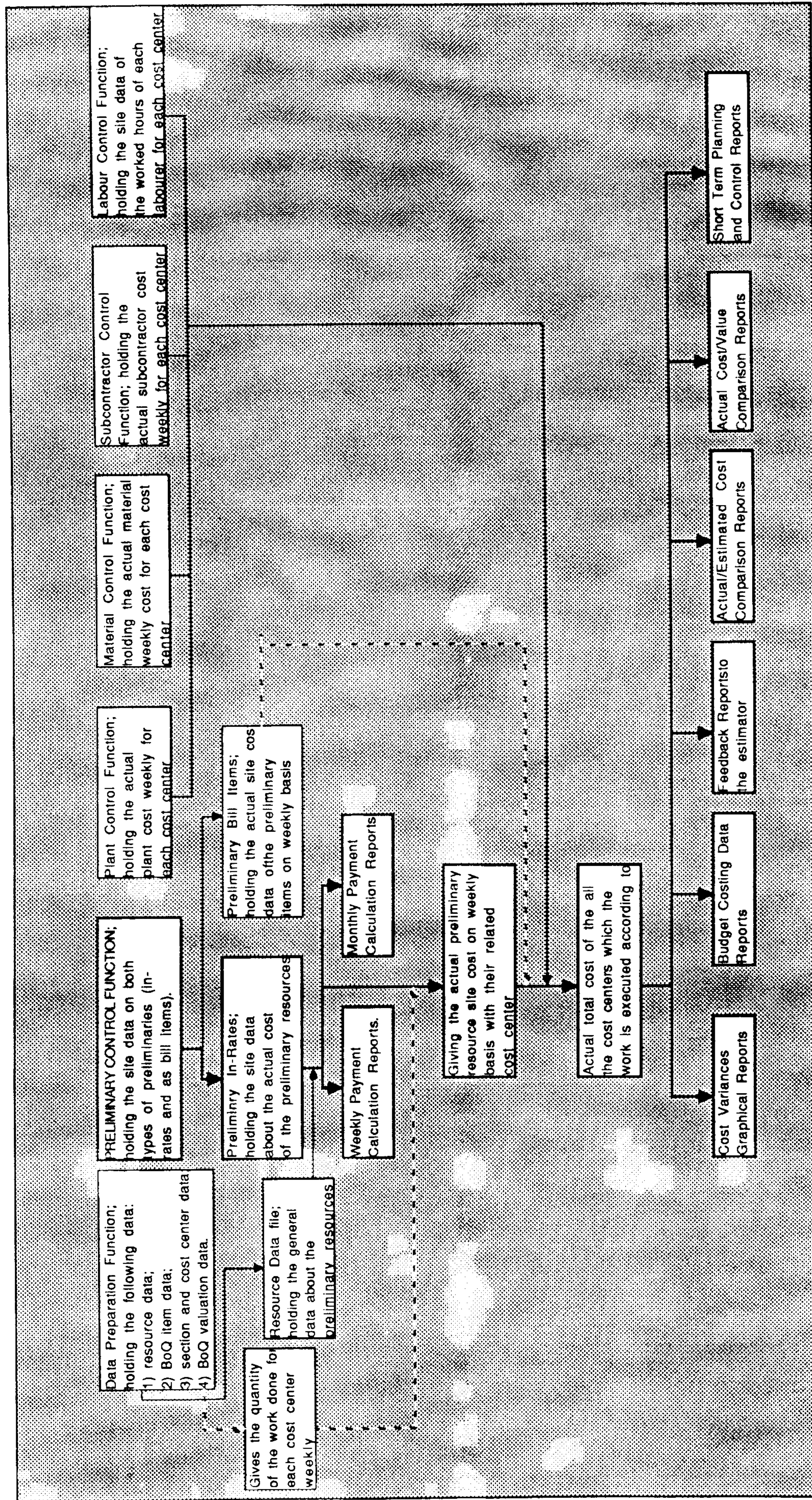


FIGURE (8.7); THE 'PLUS COST' INSIDE PROCEDURE NETWORK OF THE 'PRELIMINARY IN-RATES' FACILITY

Getting into this facility requires the user to select the option "Preliminary in-Rates", from the 'Preliminary Control on Site option in the system. Through this facility, the user could;

- i. Edit weekly payment sheet;
- ii. View weekly payment calculation;
- iii. View monthly payment Calculation.

Before the user can use this facility, the data about the resources of this type of preliminaries must be entered previously through "Data Preparation Option" if not already being accessed from the Estimating package through "Resource Data File". This data is; preliminary resource number, description, unit of measurement and rate per unit (as explained in chapter four).

1) Editing Weekly Payment Sheets

Because this type of preliminaries is usually paid on a weekly basis to the Contractor, this option in "PLUS COST" will prompt the user to enter weekly data for each preliminary code number, such as;

- related cost center code;
- cost center dedication (if known);
- this week's preliminary cost.

This data is similar to that which should be filled in the Weekly Payment Sheet, by the foreman, in the manual system.

On completion of this exercise, the user has the options; to amend, to file or to exit.

ii) View Weekly Payment Calculations

Through this option, "PLUS COST" will provide reports on the weekly payment calculations of any selected week. These reports will show the data which is supposed to be entered through the previous option 'Editing Weekly Payment Sheets', this data is; preliminary code number, description and related cost center, cost center dedication (as %) and weekly site cost. The reports are used as a weekly check on the actual figures of the in-rate preliminaries compared with the estimates. A corrective action may be ordered on the site according to this comparison.

iii) View Monthly Payment Calculations

If the monthly payment reports are required on the preliminaries in-rates of any selected month, PLUS COST through this option, will provide these on-screen reports after the month is selected. The reports will have the same headings as the previous ones (Weekly reports) but for monthly periods. These reports will give an idea of the contribution of the preliminary in-rates actual cost in the monthly actual cost of the work executed in each cost center. Also these monthly actual figures will be compared with the estimated payment figures at the adjudicating stage to be sent back as feedback reports to the Estimator.

The data entry of this function "Preliminary Control on Site" for both types of preliminaries on site with its view reports are shown in detail in Appendix L, figures (1-11).

8.5) SUMMARY AND CONCLUSION

At the end of this chapter and from what has been explained in the chapter, the following points are highlighted as a summary and a conclusion of the chapter;

- 1 - The preliminaries are usually described as those items which affect the cost of works, but do not belong to any particular work section.
- 2- The importance of considering preliminaries in the site control comes from the idea that it is difficult to work out the true value of the preliminary items, and these preliminaries can influence effectively the actual cost of the contract in either way (increasing or decreasing), if the site control system operating on site to control the preliminaries is not that efficient.
- 3 - In all the control systems which have been surveyed in this research, both those which are used by the construction companies or are available on the market (developed by computing companies), it has been found that there is no preliminary control facility in these systems (as explained in chapter two). PLUS COST is expected to be the first system that has achieved this facility in site management.
- 4 - There are three types of preliminary valuation methods which are used to estimate the preliminary payments to the Contractor within the contract, these are time related, cost related and lump sum.
- 5 - In addition to these three methods of valuation, there is a mixed method of valuation which deals with each

preliminary item separately and "PLUS COST" has been developed to depend on this method of valuation in controlling the preliminaries actual cost on site by comparing the actual costs to the payments estimated by using this mixed valuation method.

- 6 - In "PLUS COST" there are two types of control methods for preliminaries on site, depending on whether the preliminaries are solely priced in the preliminary bill items or whether they are partially or totally spread over the bill item rates and each type of the preliminaries has its site data and control sheets.
- 7 - "PLUS COST" has been developed to contain "Preliminary Control on Site" function to cover all the preliminaries incurred on site in order to get like-to-like figures in the comparison reports and to provide feedback data to the Estimator on the preliminaries to enable the Estimator to put in more competitive tenders.
- 8- "Preliminary Control on Site" function in "PLUS COST" has been divided into two parts, one for each type of preliminary (in-rates and as bill items) and the same data, required to be filled in the site sheets in the manual systems, is required to be typed in, through this function.
- 9 - For the preliminary bill items, a standard preliminary code list is required to be used on every contract without using different codes for each contract. While for the preliminary in-rates a similar coding system as for the other resources in the contract (i.e. labour, plant,

material, etc.) is used by giving them numbers which will be unique on every contract.

- 10-The reporting period required to type in the site actual cost data accordingly depends on the recurring period of the preliminary agreed payments to the Contractor (weekly, fortnightly or monthly).
- 11-The general preliminary resource data should be typed in through the "Data Preparation" function, if not already accessed from the estimating package before getting into "Preliminary in-Rate" option.
- 12-"PLUS COST" has been developed to provide view reports as well as print-out on overall project control reports on weekly/monthly basis. These reports will achieve the required preliminary control and provide feedback data to the Estimator on both types of the preliminaries for the purpose of having an accurate financial reporting system. The reports will also be used in solving the problems of controlling the preliminaries expenditure and revenue on site.
- 13-To produce the actual cost of each preliminary resource (preliminary in-rates) for each cost center, the weekly total cost of this preliminary will be divided over the cost centers from the dedication percentage, or according to the work executed in each cost center, and added to the other costs to produce the weekly actual cost of the work done for each cost center.
- 14-To produce the actual cost of each preliminary item to be compared against the estimated payments, these

items will be added together in their related cost center which is considered as a separate cost center.

15-The system remarks have been added to the figures in the comparison reports to give remarks on the comparison figures to assist the user in identifying the desirable figures in these reports.

At the end of the chapter and from the work done through it I have achieved another part of the "Business Requirements" specification by having "Preliminary Control on Site" facility. Through this facility, "PLUS COST" has achieved the construction companies requirements of controlling the preliminaries on site and assists in solving the problems of providing an efficient and accurate preliminary control on site system by using the same site data sheets which are used in the manual system. This control includes both types of preliminaries on site (in-rates and as bill items). In addition to that, "PLUS COST" provides on-screen as well as print-out control and feedback reports of the preliminary site cost and usage. So that "PLUS COST" with these features in controlling the preliminaries on site is expected to fulfill the promise of providing a computer-aided preliminary site control system as part of a whole site management system.

CHAPTER NINE

CHAPTER NINE

COST/VALUE ADJUSTMENT ON SITE

9.1) INTRODUCTION

In addition to the actual site cost/value of the work done by using the project resources, several practices may occur on the site affecting the site cost/value figures by increasing or reducing them. These site practices which are usually achieved by the Contractor on site produce extra money sums which will be either added to or subtracted from the actual site figures to produce the accurate actual gross site cost/value figures. According to these figures the Contractor will get paid. Also he will use these figures in the cost/value reconciliation and in controlling his site.

Each of the site practices such as; claims, variation orders, dayworks and price fluctuations has a different way of influencing the actual site cost/value figures. These influences could change the final contract amount figure at the end of the contract period.

The implementation of these site practices in any site management system is essential to achieve an efficient and effective site control by using accurate site figures (cost/value).

This chapter explains these practices on site and their valuation

manually. The chapter also explains the implementation of the practices in "PLUS COST" as a computer-aided site management system assisting in registration and evaluating these practices to produce the adjusting figures on site. "PLUS COST" will then use these figures to adjust the calculated actual cost/value (from the last three chapters) to produce the accurate gross site figures to be used in producing the control and feedback reports.

From the work done in this chapter as well as the last three chapters, "PLUS COST" has achieved all the Business Requirements" specification of costing and site control of the construction project and its resources. This means that the third objective will have been reached by the end of this chapter.

9.2) CLAIMS

Hughes (126), states that the face value of claims outstanding in the construction industry at any one time is enormous and it is an unfortunate fact that the number of claims is on the increase.

Making a claim's assessment involves gathering information from many different departments of a contractor's organization. What actually happens on site is of primary importance, but the estimating, planning, buying and accounting departments may all be able to confirm or enhance the details. Many, if not most contractors use computers in these departments either as aids to

decision making, or simply as calculations (ref. 133).

Within the area of computing, there are two main ways in which the machines can be used. The first is as a purely an information gathering service to eventually replace much of the paper records kept for a site. The second is as a dynamic system to keep abreast of the work as it happens and so allow examination of the effects of any changes to the schedule of resources, as well as saving time in carrying out the measurement calculations and keeping them in the Data File until the time of receiving the claim.

I considered the above two main ways when I developed "PLUS COST" in addition to the other requirements of; simplicity, good presentation and easily corrected mistakes.

The following review describes the claims, their definitions, types, headings, adequacy requirements and the manual systems for controlling them on site. From this review, the requirements of an efficient claim control on site have been identified. These requirements are considered in developing "PLUS COST" as an efficient computer-aided claim's registration and valuation.

9.2.1) Definitions of Claims

The dictionary defines the word "Claim" as meaning (ref. 125):

- to demand as due;
- to demand as right;

- a title to something;
- the assertion of a right.

The second above, is the most suitable meaning in a contractual context.

Within the construction industry, the term "Claim" is often loosely applied to any matter unsolved at a given point in time. Disputes about measurements, quantities, rates, delays, disruption or other matters to which the Contractor has rights under the contract, are frequently referred to as Claim (ref. 126).

Gunningham (127) uses a narrower definition and states that a claim is an application for additional costs, provided for by the Contract Conditions of contract Law, which allows the Contractor to recover the loss and/or expense arising from a breach or departure from the intent of that contract.

JCT Contract Conditions (ref. 136), under clauses (13, 25 and 26) explains the term Claim as "a written application for additional payment or time as a result of any loss and/or expenses in the execution of the contract or as a result of any reference to delay the progress of the work". The term "Claim" in the Civil Engineering (ICE) Conditions of Contract (ref 128) embraces both types; a claim for a higher rate or price and a claim for additional costs. Under the International Conditions of Contract (FIDIC) (ref. 129), under clause (52/5), the term Claim means; a claim for any

additional payment to which the Contractor may consider himself entitled and all extra additional work orders by the Engineer which he has executed during the preceding period (ref. 129).

The concluded definition of the construction claim is "a demand of the Contractor/Subcontractor for additional rights (payments of time) against any losses" (in time or expenses).

9.2.2) Types of Claims

There are two basic types of claims (ref. 130);

1. Claim for extra time to complete the contract.
2. Claim for extra money arising out of the contract.

Financially Chapple (130) divided the claims further into:

1. Contractual claims;
2. Ex-contractual claims;
3. Ex-gratia claims;

Hughes (126) also divides the types of claims into the following classifications (according to their matter of concern):

- i) Matters concerning the contract.
- ii) Matters concerned with the execution of the works.
- iii) Matters concerned with valuation and payment.
- iv) Matters concerned with time.

Each one is then sub-divided into the following;

- i) Matters concerning the contract:
 - a) restricted possession of the site;
 - b) claims that ground or sub-soil conditions are different from those specified or reasonably expected;
 - c) claims that late issue of information caused delay;
 - d) claims relating to variation orders;
 - e) claims relating to delay by third parties;
 - f) claims that there has been delay in inspecting the work or testing material;
 - g) claims relating to instructions;
- ii) Matters concerned with valuation and payment:
 - a) claims that there are errors in quantities, measurement or description;
 - b) claims relating to variations;
 - c) claims relating to nominated subcontractors;
 - d) claims relating to certificates and payments;
- iii) Matters concerning time:
 - a) delay, change in sequence, updating of programme;
 - b) failure to extend time-induced acceleration;

9.2.3) Heads of Claims

From the foregoing it can be seen that various heads of claims are common on site, these are (refs. 131 & 132):

1. Direct site costs.
2. Loss of production due to delay or disruption.
3. Loss resulting from the contract extending into a further winter period.
4. Increased costs.
5. Head Office charges.
6. Interest charges.
7. Loss of profits.
8. Subcontractors claims.

9.2.4) Claim's Registration and Measurement on Site Manually

There are two main types of claims according to the ICE (ref. 128) and JCT (ref. 136) contract conditions on which "PLUS COST" has been developed in dealing with claims on site. The contractor's duties in these two types are explained as follows:

i) Extension of Time

The contractor's duties, as in JCT Conditions, clause (25) and ICE Condition, under clause(44), are;

- As soon as the Contractor thinks that he is being delayed or is likely to be delayed in the future, he must

immediately notify the Architect/ Engineer in writing.

- The Contractor must give details of the expected results of the relevant events as soon as possible.
- The Contractor must estimate the extent of the expected delay beyond the contract completion date as soon as possible.
- The Contractor must give further notice to update the particulars of any delays and expectations from time to time.
- Once the Contractor realizes that the item on which the delay happened has been finished, he can submit a claim for extension of time normally with all the evidence in support.

ii) *Loss and/or Expenses*

The contractor's duties according to JCT conditions (ref.136), under clauses (26, 13.5, 34.3) and ICE Contract Conditions (ref. 128), clauses (51) are:

- the Contractor must notify any changes which have affected his progress in a substantial way at the proper time;
- unless the Contractor has received necessary instructions at the proper time, he must apply in writing as noted;
- once the involved item(s) have been finished by the Contractor, he can use them with all the relevant documents in support of his claim;

- the claim will be negotiated and can then be agreed according to the reality of the evidence attached;

9.2.5) The Adequacy of a Claim

There are three major points to be considered before starting any detailed work. These are as described by Hughes (132):

1. The validity of the claim;
2. The existence of adequate records;
3. The possible scope of the claims.

The more difficult settlements are those involving the question of responsibility for work and those where the effect of the initial event is carried further into the programme (ref.127). The first type of dispute may require examination of the legalities of the contract as well as records of work. The second depends almost entirely on documentation. Because the full effect of a claim situation may not become apparent until some time after the causative event, it is imperative that site records are kept as complete as possible.

On the construction site, changes to the original plan of working are many and varied. Besides variations ordered by the client, there may be plant breakdown, labour disputes, bad weather, delays in almost everything, and inevitably, the unforeseen circumstances.

While it is possible to record all that occurs on site by the well-proven manual method, there are several drawbacks. Many people tend to be lax about writing up records and often put it off until later when their memory of the work is less accurate. Although records may be complete as far as work done is concerned, a great many claims are about what was not done either at the right time or at all. This negative aspect of recording is seldom very comprehensive and this, in particular, makes claims for delay very difficult to substantiate. A further drawback is the amount of time and effort required to find and assemble all the relevant records for a claim.

These reasons serve to highlight the difficulties of making an adequate claim and explain why a great many claims are settled by "HORSE DEALING" or "GIVE AND TAKE" between client and Contractor.

9.2.6) "PLUS COST" Aiding Claim Registration And Measurement on Site

The first construction management system which considered this facility "Claim Registration and Measurement" was PLUS VAL (ref. 62). This valuation system considered the claims only as part of its interim valuation to the Contractor. However, If such a system is available to be linked to "PLUS COST", there will be no need for using this facility in PLUS COST for entering the claims data. All the required data about the claims will be accessed from PLUS VAL data files by calling them

through PLUS COST. At the same time and in case the valuation system is not available, "PLUS COST" will give access to the user to enter the data about the claim's registration and measurement manually.

However, "PLUS COST" as a site management system has been developed to achieve the following objectives from "Claims" as one of its functions:

1. To assist the Contractor on site in having adequate claims, PLUS COST provides a facility of registration of all the records and the documents which could support the validity of the site claims. These site records of claims will be stored in the "Claim Data File" through the system and kept as complete as possible to be used by the Contractor for raising his claim.
2. To assist the Contractor on site in having a more accurate and updated measurement of the claims on site, for both types; those accepted and not yet accepted to be paid. These measurements will then be shown in the controlling reports of the system to give the user accurate figures of the actual cost and value on site as well as the expected figures from claims not yet accepted.

So far, none of the available site control and management systems considered the claims in controlling the construction site, and that made the available systems inefficient. "PLUS COST" is the

first site management system that considered this site practice in its site control and management. Through this facility and by achieving the above two objectives, PLUS COST will provide more accurate site figures and more efficient site control and management.

"PLUS COST" in its dealing with claims on site considers Loss/Expenses claims only and not the other type (extension of time), because the second type deals with time more than with cost or expenses on site which "PLUS COST" is dealing with. So that the "Extension of Time Claim" has more influence in the planning systems than in "PLUS COST".

Through "Claims" function in "PLUS COST", the user will enter all the site data related to the claims measurement and registration (if it can not be accessed from the other management systems). "PLUS COST" will then do all the required calculations to produce the amount of the claims (both accepted and not yet accepted) These amounts will be shown in the cost / value comparison and the feedback reports. By adding the total cost of the accepted claims to the actual value of the work done, as well as the other practices, the gross actual value of the work executed will be produced. The amount of the claims not yet accepted will be shown also in these reports just to give an idea to the user that there may be more money coming from these claims in the future, when they are accepted by the client/promoter. The use of claim calculations in producing the controlling and feedback reports is

explained in chapter eleven.

The flow chart of "PLUS COST" inside procedures of "Claims" function is shown in figure (9.1).

To use this facility in "PLUS COST", the "Claims" function needs to be selected. That will offer another two options;

- i. Registration of Claims;
- ii. Measurement of Claims;

i) Registration of Claims

This option will offer a further two options;

- a) Edit Claim Registration;
- b) View Claim Summary.

a) Editing Claim Registration

Through this option, the user will be prompted to enter all the general data on the claims such as; claims' number, description, date, subject to price fluctuation and acceptance and any related documents.

After the above data has been entered, the system will show all the typed-in data on the screen with three options; to amend, to file or to exit. This data will be stored in the "Claim Data File" through "PLUS COST" according to the "Claim Number". Also through this option the user can update any filed data of any claim entered before.

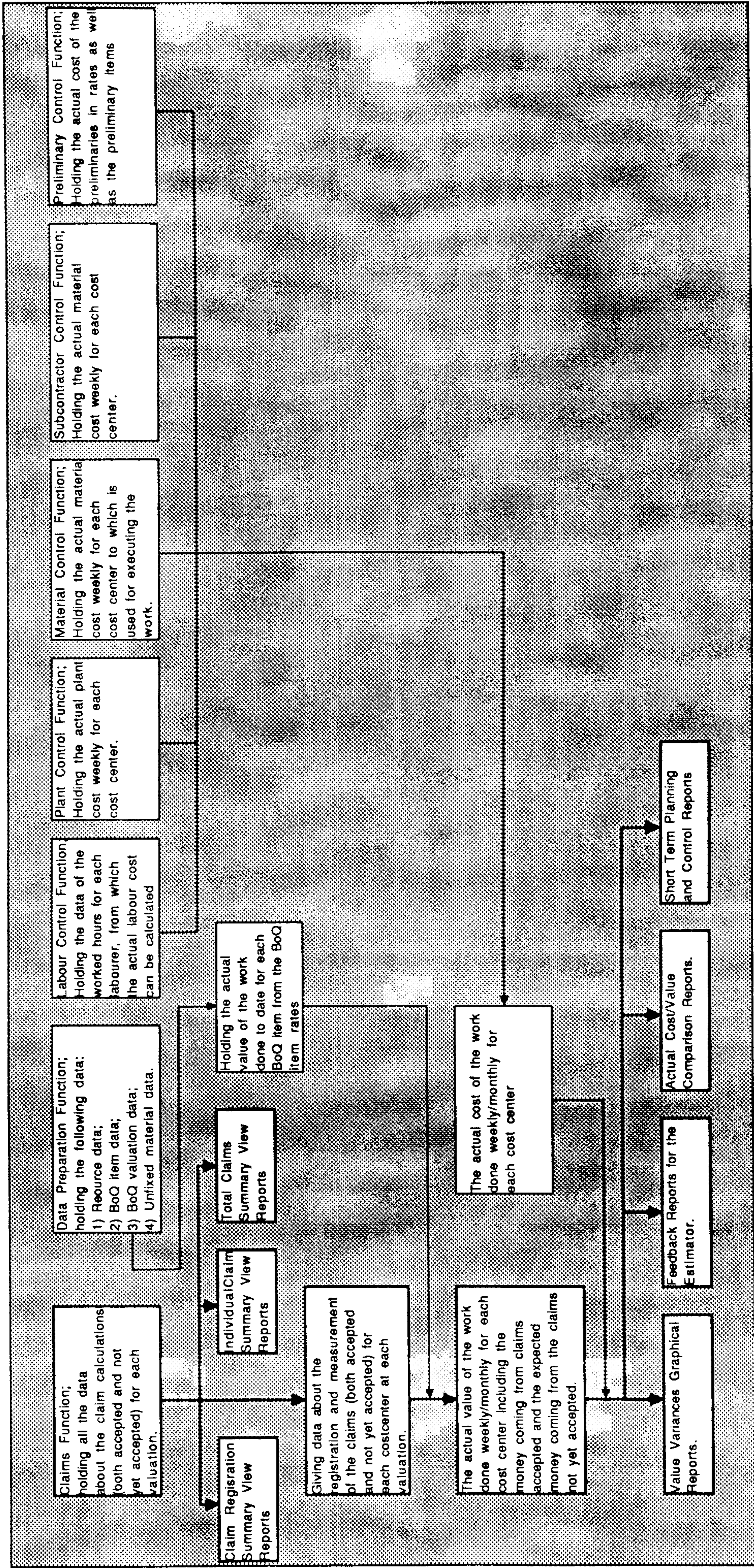


FIGURE (9.1); "PLUS COST" INSIDE PROCEDURE FOR "CLAIMS" FUNCTION

b) View Claim Summary

This option will provide on-screen summary reports of all the claims registered in "PLUS COST" from the beginning of the contract till the date of the report. The summary will include, claim's number, description, date and if it is accepted or not.

From these reports, the Contractor could go back from time to time and check the claims raised and their condition of acceptance, especially at the time of the interim valuation. So that he can identify exactly the money from the accepted claims and this expected amount from claims not yet accepted.

ii) Measurement of Claims

If the user selected this option, he could then;

- a) Edit claim measurement;
- b) View individual claim summary;
- c) View total claim summary.

a) Editing Claim Measurement

Through this option, the user will be prompted, at each valuation, to enter the valuation data of each claim occurred through that valuation. This data will include the resource groups involved (i.e. labour, plant, material, etc.). Through each group, the following valuation data of each resource number involved will be required to be entered:

- _ resource quantity used in the claim;
- _ resource basic rate (if different from what existed in the Resource Data File).

After the data has been entered for each group of resources, "PLUS COST" will display the typed-in data on the screen with an option to do any amendment, otherwise, the system will go to the next group of resources, till all the resources are typed in. "PLUS COST" will ask for the additional profit/overheads (as percentage of the total cost of the claim from the basic rates of the resources) to be entered.

The system will then store the measurement data in the Claim Measurement File" under its claim number (which is supposed to be entered before through "Editing Claim Registration" option).

b) View Individual Claim Summary

This option will provide the user with on-screen summary reports of any individual claim number which show the resource groups involved, their basic costs, their expected profit/overheads and then their totals, from which the overall claim total will be shown as well. These reports will assist the Contractor in preparing his claims before applying them to the client at the valuation time.

c) View Total Claims Summary

If this option has been selected, "PLUS COST"

will provide the user with on-screen reports on the claims of any selected valuation number. In providing these reports, "PLUS COST" will multiply the measurement of the resources (involved in each claim of that selected valuation) by the basic rates of these resources (entered previously through Data Preparation option) to calculate the basic costs. These costs will then be added together to calculate the total basic cost. The additions for profits and/or overheads for each type of resources will be added to calculate the total additions for each claim. After that, "PLUS COST" will show through the reports, the claim raised in this valuation, their basic costs (as total), the additional cost for profit/overheads, then their overall totals. These overall totals will then be added together to produce the expected total from claims for that selected valuation number. These reports and the previous ones, will assist the user at the time of valuation to get an idea about the expected money coming from the claims raised.

The data entry and the view reports of "Claims" are shown in detail in Appendix M, figures (1-8).

9.3) VARIATION ORDERS

Variation order is another site practice which can rarely be avoided in any contract. The variation order can be developed as a claim if there is no agreement between the contract parties on the figures of these varied quantities or rates.

These variation orders will influence the contract amount at the end of the contract period because of the omissions or additions in the item rates or quantities as a result of changing or replacing the drawing or the method of executing the contract.

However, to achieve practically and accurately more efficient cost control procedures on site, these orders must be considered at the cost/value reconciliation stage by adding or omitting the variation values to that from the internal valuation which is done by the Contractor's Quantity Surveyor. So that the actual value figures will be more accurate and that will lead to better reconciliation procedures.

This following review describes the variation orders on site, their definitions, types, and handling on the site manually. The review then explains the implementation of the variation orders in "PLUS COST" as a computer-aided variation orders control (registration and measurements) on site.

9.3.1) Variation Order Definitions

The dictionary gives the definitions of the term "Variation" as; the act, process, condition, or result of changing or varying, an instance of varying the amount, rate, or degree of such change.

The JCT Conditions (ref. 136) in clause (13) states the term "Variation" as used in these conditions, means "the alteration or

modification of the design, quality or quantity of the works as shown upon the Contract Drawings and described by or referred to in the Contract Bills". This includes; the addition, omission, or substitution of any work, the alteration of the kind or standard of any of the materials or goods to be used in the works. Also it could be the removal from the site of any work executed or materials or goods executed or bought thereon by the Contractor for the purposes of the works other than work material or goods which are not in, accordance with this contract.

In ICE Conditions (ref. 128), clause (51/1) the term "Variation" means "any changes which may include additions, omissions, alterations, changes in quantity, form, character, kind, position, dimension, level or line and changes in the specified sequence method or timing of construction (if any)".

The International Contract Conditions FIDIC (ref.129) defines "Variation" in clause (51/1) as "any change in the form, quantity or quality of the works". These changes may be one of the following:

- a) increase or decrease in the quantity of any work included in the contract;
- b) omit any such work;
- c) change the character, quality or kind of any such work included in the contract;
- d) change the levels, lines, position and dimensions of any part of the works;
- e) execute additional work of any kind

necessary for the completion of the works.

Briefly from the definitions of the term "Variation" in the contract condition (ICE, JCT and FIDIC), which are mentioned above, "Variation Orders" can be described in general as; "written order given by the Architect/Engineer to the Contractor to make any changes in the form, quantity, or quality of the work".

9.3.2) Handling of Variation Orders on Site Manually

Despite the complete planning and documentation, and because of the site and/or the work conditions which may require changing in the drawings, details, instructions, quality and/or quantity of the work, so that it will probably be necessary from time to time for the Architect/ Engineer to issue further drawings, details and instructions which are collectively known as "Architect / Engineer Instructions". These instructions must be in writing as shown in figure (9.2).

The Architect's/Engineer's Instruction will describe the varied work and state any item(s) to be omitted, and will record any new or amended drawings which are to be worked to. If the instructions involve the adjustment of prime cost sums, particulars must be given of the estimate which is to be accepted, stating the date of the quotation and the reference number as well as the total value of the proposed accepted estimate (ref. 119).

The valuation of these ordered variation will vary according to the type of the contract. In Building Contracts and according to JCT (136), the variation orders will be measured and valued by the Promoter's Quantity Surveyor who will give the Contractor the opportunity to be represented and to take such notes and measurements as he may require, unless an estimate made by the Contractor is accepted by the Architect as a lump sum. While in the Civil Engineering Contracts and according to ICE and FIDIC (refs. 128 and 129) the value of all the variation ordered by the Engineer shall be ascertained by himself after consultation with the Contractor in accordance with the following principles (ref. 128);

- Where work is of a similar character or executed under similar conditions to work priced in the BoQ, it shall be valued at such rates and prices contained therein;
- Where work is not of a similar character or is being executed depending on the rates and prices of the BoQ as basis; this valuation must be done by the Engineer and must motivate the Contractor .

All the omissions from the Contractor shall be valued at the rates contained in the contract bills. Unless omissions are of such an extensive nature that they vary substantially from the contract conditions under which the remaining work must be carried out when the rates for the remaining works shall be valued.

The three Contract Conditions ICE, JCT and FIDIC (refs. 136,128 &

129 respectively) clearly state that interim valuation shall include any costs due to variation or adjustment of provisional sums and it is therefore, important that the Engineer/Quantity Surveyor should keep up to date with the measurement and valuation of authorized variations.

The forms which are used in handling the variation orders on site manually are shown in Appendix N, figures (1-5).

9.3.3) Computer-Aided Registration And Valuation of Variation Orders on Site By Using "PLUS COST"

So far, all the available site management systems have not considered the variation orders (as a site practice) in controlling the construction site, and that made these systems inefficient (ref. 57).

"PLUS COST" is the first site management system which has been designed to have "Variation Orders" as a function in controlling the construction site. So that, whenever the Internal Valuation is calculated by the Contractor's Quantity Surveyor, additional values such as variation orders will be added to the actual values, in addition to the other practices, to produce the actual gross value of the work executed before achieving reconciliation reports. These reports will show more accurately the actual gross value figures for any controlling and feedback as explained in chapter eleven.

The valuation system (PLUS VAL) has also the facility of Variation

Orders Registration and Measurements, which is used in calculating the interim valuation of the contractor's work (as in claims). So that, if PLUS VAL is available to be linked to PLUS COST, there will be no need to go through this option in PLUS COST. PLUS COST will automatically take all the required variation data from PLUS VAL by calling its data files whenever required in the calculations. Otherwise, the user has got to enter all the data about variation orders (records and measurements) through this facility, in PLUS COST, in case PLUS COST is not available.

The "PLUS COST" internal procedure network for the "Variation Orders" facility is shown in figure (9.3).

The user must select "Variation Orders" option from the system which will offer him choices to:

- i. Edit variation orders (general data);
- ii. Edit variation order items;
- iii. View variation order summary;
- iv. View variation order accounts.

i) *Editing Variation Orders*

This option prompts the user to enter the general information about the orders such as; order code number, date of issue, instructions number and the related reference codes. This data will be entered by answering a list of interactive questions which will be displayed on the screen.

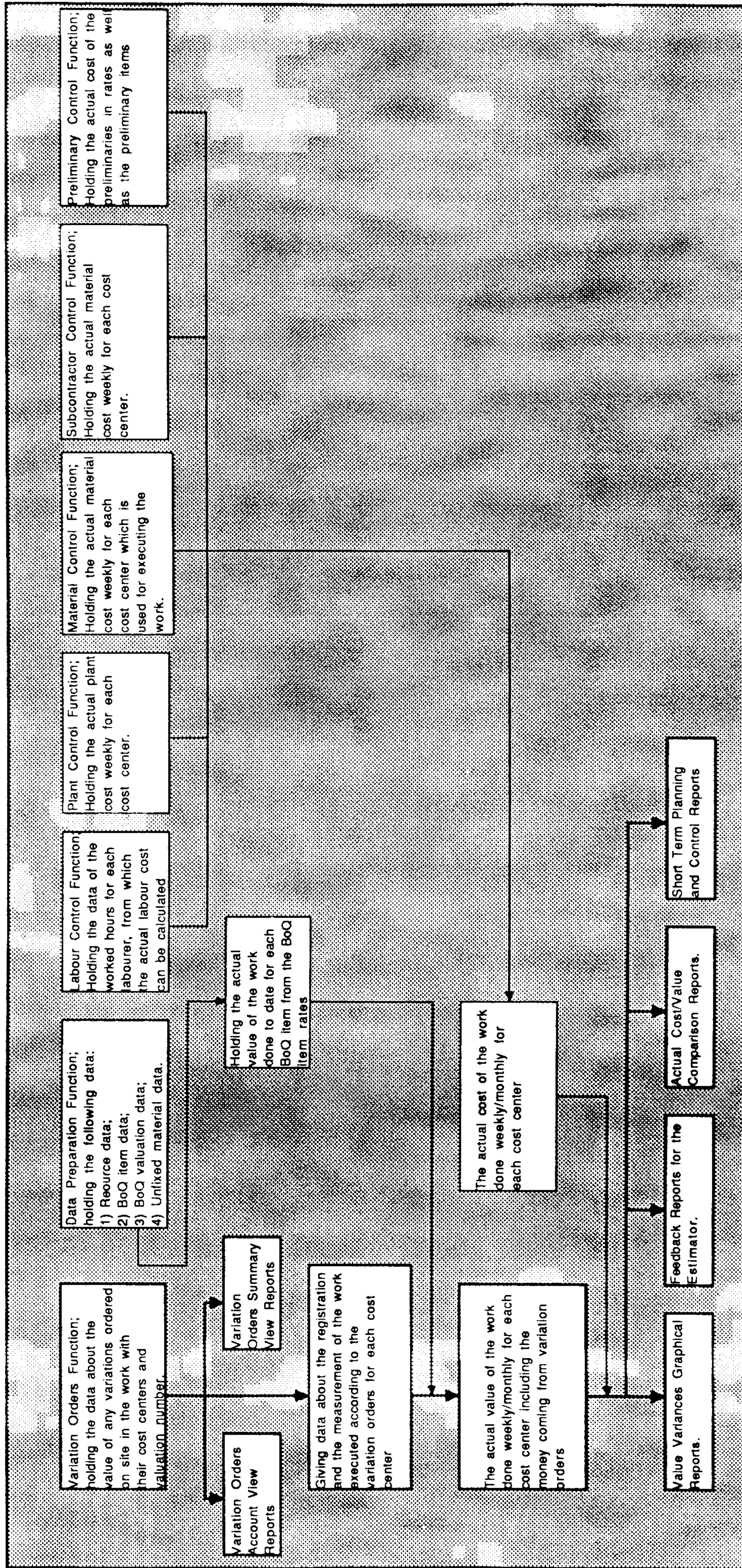


FIGURE (9.3); "PLUS COST" INSIDE PROCEDURE FOR "VARIATION ORDERS" FUNCTION

If all the above data has been entered, "PLUS COST" will show it on the screen with the options; to amend, to file or to exit, so that the user can make any amendment on the data before it is filed in the "Variation Data File".

Also this option can be used to update the general data of any variation order filed in the Variation Data File.

ii) *Editing Variation Orders Items*

If this option has been selected, "PLUS COST" will enquire about the BoQ item code required (must exist in the BoQ Data File after being entered through Data Preparation option, as explained in chapter five, or accessed from Estimating system data files), the variation order page number and its item's number in the variation order. The system will then search the "Data File of BoQ" (which is supposed to have its data accessed from the Estimating system or entered through "Data Preparation Option") to select the required item and show it on the screen with the options;

- Amend Item Quantity;
- Amend Item Rate.

By selecting either of these two options, "PLUS COST" will ask for the type of the amendment required on the BoQ figures according to the variation order:

- Add to BoQ Figures;
- Subtract from BoQ Figures;

- Replace BoQ Figures.

So that the user can do any amendment that may be ordered on the site by the Architect/Engineer. "PLUS COST" will do the rest of the calculations to show the order's item with its data which is;

- variation order item number;
- variation order page number;
- item unit of measurement;
- item old rate;
- item new rate;
- item old quantity;
- item new quantity.

With an option to do any amendment on this data, before being filed, the user can also update any variation order item entered before through this option whenever required.

These variation order items will be used in calculating the value of the variation orders to be added to the actual internal value of the work executed as one of the adjustments required to produce the actual gross value of the work done.

iii) View Variation Orders Summary

"PLUS COST" will prompt the user through this option to get on-screen summary reports of the variation that are ordered by the Architect/Engineer and entered into the system.

These reports will be used by the Contractor to check reports on the variation orders documents at the time of the interim valuation to see if he is being paid for the variation orders as recorded.

iv) *View Variation Orders Accounts*

If this option is selected, "PLUS COST" will do all the required calculations to produce on-screen reports of any selected variation order number. These reports will show the following data for any selected order number;

- variation order description;
- item number (in the variation order);
- item description;
- item unit of measurement;
- the amount (if it is omission or addition);
- net variation order total;

"PLUS COST" has been developed to display such reports to be similar to the "Architect/Engineer Instruction Form" or to what is called "Draft Variation Account", which the construction companies use on site in their manual systems. According to this form, the Contractor will get paid for the variation order.

Appendix O, figures (1-6) show in detail the data entry and the on-screen reports of the "Variation Orders" function in "PLUS COST".

At the end of this review on the variation orders control on site and from what has been explained, "PLUS COST" will achieve the requirements of having an efficient computer-aided control variation orders (registration and measurements) on-site system, to be used in controlling and managing the construction site.

9.4) DAYWORK

This is also another site practice which might occur on the site and influence the actual value of the work by making it need adjusting before making any payments, or any reconciliation.

The day work is considered as a type of variation (as an additional or substituted work) which is ordered to be executed on a daywork basis.

The daywork is used usually to value a special type of variation on site according to orders given by the Engineer/Architect to the Contractor on site.

The following review describes this site practice, its definition, way of handling on site manually and then its implementation in "PLUS COST" as a computer-aided on-site daywork control system as part of a site management system for controlling and managing the construction site.

9.4.1) Definitions of Daywork

Each type of the Contract Conditions may define the Daywork differently, but all end in the same condition of ordering the Daywork as a way of evaluating the variation Orders on Site.

JCT Contract Conditions (ref. 136), under clause (13.5.4), defines Daywork as; "a type of valuation for work which cannot be properly valued by measurement". ICE Contract Conditions (ref. 128), under clause (52.3), explains that "the Engineer may if in his mind it is necessary or desirable, order in writing that additional or substituted work shall be executed on a daywork basis". FIDIC Contract Conditions (ref. 129), under clause (52.4) explain the term Daywork in the same way as in the ICE Conditions above.

We can therefore, conclude that, "work which cannot be properly valued by measurement and can only be valued by measuring time must be valued by daywork, so long as the previous is complied with". This should in theory prevent the fairly common practice of using the recorded time on daywork as a means to establish a price for an item which has been purported to be measured by some other means.

9.4.2) Daywork Handling on Site Manually

After it has been decided by the Engineer/ Architect in writing that such work has got to be executed on a daywork basis, the Contractor by using "The Daywork Sheet" on site, figure (9.4), registers and measures the work daily, by filling

Day Work Sheet

No _____

CONTRACT: _____

Week Ending: _____

Description of Work: _____

Architects Instruction No _____

Labour

EMPLOYEE	DESCRIPTION	M	T	W	Th	F	S	Su	WAGE	TOTALS

Labour: Sub-total _____
% Addition _____

Materials

DESCRIPTION	QUANTITY	UNIT RATE	TOTALS

Materials: Sub-total _____
% Additions _____

Plant

DESCRIPTION	HOURS	RATE	TOTALS

Plant Sub-total _____
% Addition _____

GRAND TOTAL _____

FIGURE (9.4); A SAMPLE OF A DAYWORK SHEET USED ON THE SITE

in, in duplicate, an exact list of the names, occupation, and time of all the workmen employed. Also the Contractor shall fill in the quantity of all the materials and plant used in the daywork. These sheets (Daywork Sheets) are necessary to prove the amounts to be paid for the quantity of materials and type of machinery used, because they are signed by the client's representative. One copy of the sheet will (when agreed) be signed by the Engineer's/ Architect's Representative and returned to the Contractor. At the end of the month, the Contractor shall deliver to the Engineer's/ Architect's Representative a "Priced Daywork Statement" of the labour, material and plant used, figure (9.5), on which the Contractor will be entitled to any payment for such work. The payment for the Daywork may be treated in either of the following two ways:

- valuation against provisional sums in the BoQ;
- maintenance of a separate daywork account which is brought forward only in a summary of valuation;

9.4.3) Computer-Aided Daywork Registration and Measurement on Site By Using "PLUS COST".

So far, none of the site management systems have considered the Daywork's valuation in controlling the site cost (ref. 57). It was considered by some of the valuation systems such as "PLUS VAL" (ref. 62) which is doing the valuation of the dayworks to be used in the interim valuation of the Contractor. That has made these systems inefficient in controlling the construction site. PLUS COST is the first

Contract _____ Week Ending _____ NO. _____												
STATEMENT OF DAYWORK												
Description of Works and Materials used	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Total	Rate	Labour (1)	Materials (2)	Plant (3)
									Total of (1) (2) and (3)			

FIGURE (9.5); A SAMPLE OF A DAYWORK STATEMENT USED ON SITE

integrated site management system which is considering this practice (daywork) in controlling and managing the construction site cost.

The daywork records and measurements can be provided for PLUS COST by one of two ways, either by linking PLUS COST to the valuation system (PLUS VAL), so that the required data will be accessed from PLUS VAL data files, or by entering the required data manually by the user in PLUS COST through this function.

Through this facility, "PLUS COST" will use the measurements to produce the value of the work which was executed on a daywork basis (for both Contractor and subcontractor) from the resources used and the time spent. This value will be added to the actual value of the work executed according to the BoQ items. The money that comes from the total gross actual value of the work executed will be produced to be used in the reconciliation and feedback reports.

Figure (9.6) shows the "PLUS COST" internal procedures network of the "Daywork" facility.

To use this facility in PLUS COST the user has to select "Daywork" function from the system. Through which the user can;

- i. Edit daywork sheets;
- ii. View daywork sheets.

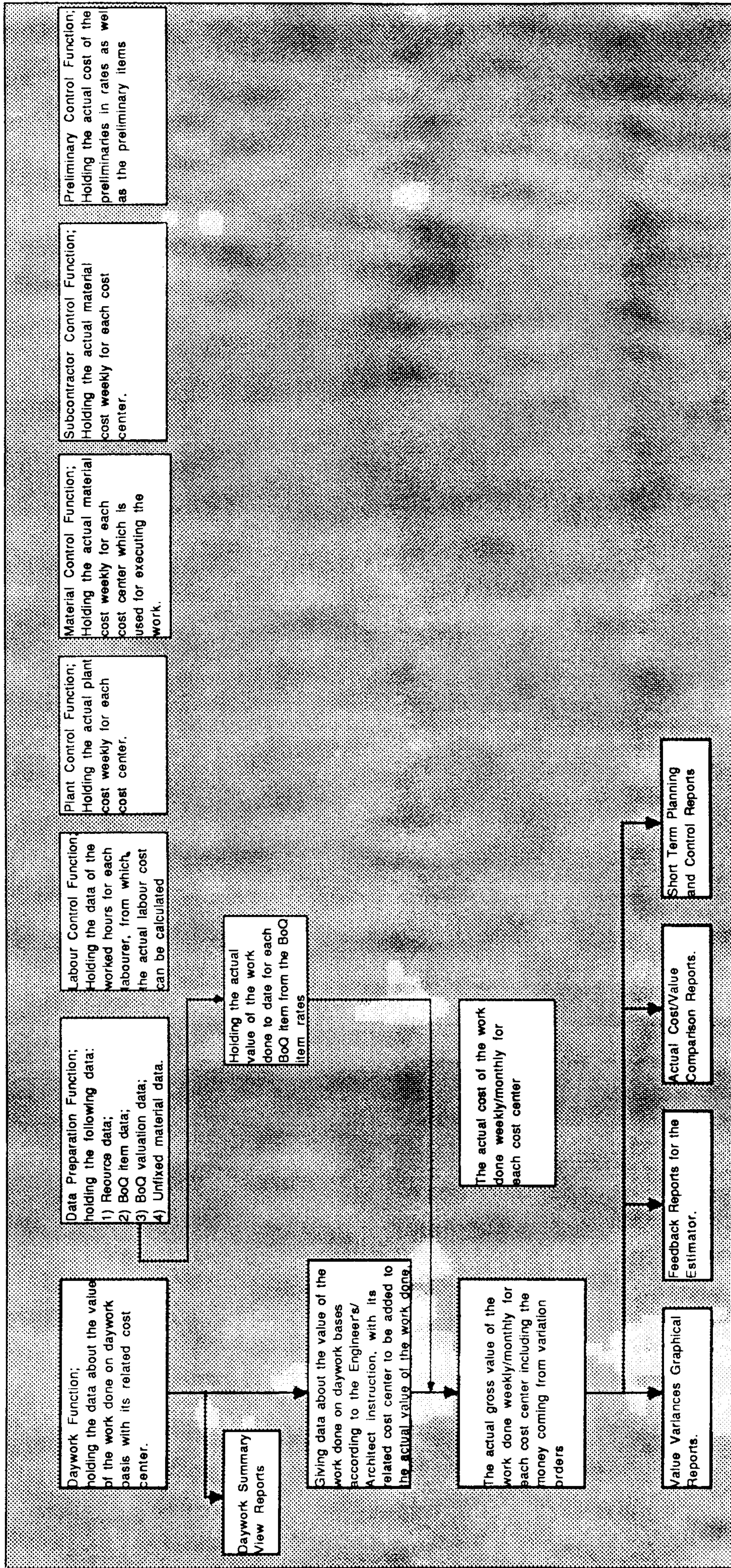


FIGURE (9.6); "PLUS COST" INSIDE PROCEDURE FOR 'DAYWORK' FUNCTION

i) *Editing Daywork Sheets*

Through this option, "PLUS COST" will ask the user to type in the same data that is required to be filled in the "Daywork Sheet", as shown in figure (9.4), by answering a list of interactive questions appearing on the screen. The resources involved in the daywork will be entered in groups (i.e. labour, plant, material, etc.). For each resource number (must exist in Resource Data File) the user must enter the data of:

- Resource Quantity;
- Resource Basic Rate;
- Rate Additions for Profit/Overheads (as %).

After entering all the resources in each group, "PLUS COST" will display the typed-in data of the group resources as well as the general data of the sheet with an option for "any amendment before going to the next group of resources, till all the resources involved are typed in through their groups. "PLUS COST" will then store this data under its sheet number in the "Daywork Data File" through the system to be used then for calculating the value of the work executed on the daywork basis. This calculated value will be added to the value of the work done by the BoQ items, as well as the other adjustments like claims or variations orders to produce the gross value of the work executed.

ii) *View Daywork Sheet reports*

This option will provide on-screen reports of any selected daywork sheet number with all the details which

were supposed to be entered through the previous option. These reports will save in the time and the staff required by the Contractor to prepare his monthly statement to submit it to the Engineer's / Architect's Representative on site by checking the daywork sheets of the required month through these reports. The reports will also give accurate figures which will be used by the Contractor in calculating the payment due to him from the dayworks of that month.

The data entry and the view reports of the "Daywork" function are shown in detail in Appendix P, figures (1-4).

9.5) PRICE ADJUSTMENT

This is another site practice that might appear on site causing changes in the agreed value of the contract figures. It is usually defined as "any decrease or increase in the officially agreed rates of wages or variations in the market price of materials and plant" (ref. 142). Where they are in operation, the fluctuations should be assessed and included in each internal valuation. The assessment of the value of the fluctuations in the prices of the materials or the plant will change the actual value of the work executed.

On site, different methods are used to assess the value of the fluctuations depending on the contract type (if it is Civil Engineering, Building or International contracts).

However, this review explains this practice with its methods of assessment and handling on the site manually. It also explains how "PLUS COST" can assist in calculating the value of the price fluctuations to be included in the actual values before doing any reconciliations.

9.5.1) The Assessment of Price Fluctuations

In assessing the value of fluctuations, there are two methods. The first one called "The Orthodox Method" which is based on information supplied by the Contractor in respect of the amount and the value of labour and materials used on the work (ref. 74). The second method is an application of price adjustment formula from "The National Economic Development Office (NEDO)". This formula was introduced by the Property Service Agency (PSA) as an alternative to the "Labourious Orthodox Method" of assessment by analysis. The method (NEDO) is a much quicker and easier method showing a reasonable degree of accuracy and results in earlier payments to the contractor (ref. 74). "PLUS COST" has been developed to achieve the price adjustment facility by using this method for both:

- i. Building Contracts;
- ii. Civil Engineering Contracts.

i) *NEDO Formula Method For Building Contracts*

This price adjustment method is based on indices published by "Her Majesty's Stationary Office (HMSO)", in monthly bulletins under the auspices of NEDO (ref. 74). The

Department of Industry provides the information for materials indices and the Department of the Environment provides labour indices (a description of the indices and their application and procedure has been produced by the PSA (ref. 74).

In these HMSO indices, the Building work is divided into 48 work categories which can be grouped into Work Groups (combination of work categories into weighted work groups) as shown in figure (9.7).

A schedule is prepared before the contract is signed to show the work categories/groups that are in use. "Base Month Indices" are established at the time the tender is submitted. The base index for any work category/ group is the index shown on the list for the base month. By using the "Building Formula" (ref. 151), the value of the work executed in each work category during the valuation is calculated. The price adjustment for each category/group is taken to a general summary and the net increase or decrease is added to or deducted from the valuation (ref. 151).

The "Building Formula" covers price adjustment in respect of the main contract between the employer "Building Owner" and the "Main Contractor". It may also be applied to certain subcontractors and specialist work.

WORK GROUP	DESCRIPTION	WORK CATEGORY NO.
A	DEMOLITIONS	2/1
	SITE PREPARATION, EXCAVATION AND DISPOSAL	2/2
	HARDCORE AND IMPORTED FILLING	2/3
	GENERAL PILING	2/4
	STEEL SHEET PILING	2/5
B	CONCRETE	2/6
	REINFORCEMENT	2/7
	STRUCTURAL PRE-CAST AND PRE-STRESSED CONCRETE UNIT	2/8
	NON-STRUCTURAL PRE-CAST CONCRETE COMPONENTS	2/9
	FORMWORK	2/10
C	BRICKWORK AND BLOCKWORK	2/11
D	NATURAL STONE	2/12
E	ASPHALT WORK	2/13
	SALTE AND TILE ROOFING	2/14
	ASBESTOS CEMENT SHEET ROOFING AND CLADDING	2/15
	PLASIC COATED SHEET ROOFING AND CLADDING	2/16
	ALUMINUIM SHEET ROOFING AND CLADDING	2/17
	BUILT-UP FELT ROOFING	2/18
	BUILT-UP FELT ROOFING ON METAL DECKING	2/19
F	CARPENTRY, MANUFACTURED BOARDS AND SOFTWOOD FLOORING	2/20
	HARDWOOD FLOORING	2/21
	SOFTWOOD JOINERY	2/24
	HARDWOOD JOINERY	2/25
	IRONMONGERY	2/26
G	STEELWORK	2/27
H	STEEL WINDOWS AND DOORS	2/28
	ALUMINUM WINDOWS AND DOORS	2/29
	MISCELLANEOUS METALWORK	2/30
I	CAST IRON PIPES AND FITTINGS	2/31
	PLASTIC PIPES AND FITTINGS	2/32
	COPPER TUBES, FITTINGS AND CYLINDERS	2/33
	MILL STEE PIPES, FITTINGS AND TANKS	2/34
	BOILERS, PUMPS AND RADIATORS	2/35
	SANITARY FITTINGS	2/36
	INSTRUCTION	2/37
J	TILE AND SHEET FLOORING (VINYL ETC.)	2/22
	JOINTLESS FLOORING (EPOXY RESIN TYPE)	2/23
	PLASTERING TO WALLS AND CEILINGS	2/38
	BEDS AND SCREEDS (ALL TYPES) TO FLOORS, ROOFS AND PAVINGS	2/39
	DRY PARTITIONS AND LININGS	2/40
	TILING AND TERRAZZO WORK	2/41
	SUSPENDED CEILINGS (DRY CONSTRUCTION)	2/42
K	CLASS, MIRROS AND PATENT GLAZING	2/43
L	DECORATIONS	2/44
M	DRAINAGE PIPEWORK (OTHER THAN CAST IRON)	2/45
	FENCIGN GATES AND SCREENS	2/46
	TARMACADAM SURFACING TO ROADS AND PATHS	2/47
	SOFT LANDSCAPING	2/48

FIGURE (9.7); LIST OF SERIES(2) FORMULA WORK CATEGORIES SHOWING THEIR GROUPING INTO WORK GROUPS

Alternative methods of applying the formula may be used, the choice being between the use of:

- Work Categories Method;
- Work Groups Method.

"PLUS COST" has been developed to work on "Work Group Method" to match in with grouping the items into Cost Centers, so that these cost centers can be used as work groups themselves, to make using this facility through "PLUS COST" much easier.

However, in the "Work Group Method", the application of the work groups is formed by combining the work categories into Weighted Work Groups. The number of work groups can be varied, even down to one (for example on a repetitive housing contract). The tender must be analyzed into work categories within the selected work groups. The value of work executed in every valuation period is allocated to the selected work groups. Although this method involves the calculation of weighted indices for each work group from the tender stage and for each valuation, there is less work in segregating the value of work carried out in every valuation.

The PSA, however, have stated that the " Work Group Method", will always be used and has also decided on a fixed number of work groups. The way of using this method is explained in detail in the references (146, 148, 150 and 151).

The "Work Group Method" can be used also for adjusting the

variations and that will depend on (ref. 151):

- the variation orders being priced at rates included in the contract bills, the increased rates can be calculated by using the above methods;
- the variations not being priced at bill rates, then either of the following procedures should be applied;
- the work is valued and paid for at current prices;
- a new Base Month Indices may be agreed and the formula separately applied to the variation when executed and valued on site;

ii) *NEDO Formula Method For Civil Engineering Contract*

This method uses a formula based on indices for the adjustment of the contract price in the Civil Engineering Contracts in respect of an increase/decrease in the cost of labour, material and plant (ref. 147). A working group in the Economic Development Committee for Civil Engineering which recommended this method, advises on the operation and future development of the formula method of price adjustment originally developed by the Committee on behalf of the "National Economic Development Office (NEDO)".

There is now a separate NEDO formula for Civil Engineering contracts. This formula is sometimes referred to, by Mr. J. M. Baxter (the chairman of the Committee) who produced the recommendations (separate publications) of Price Adjustment Formula for Civil Engineering Contracts for: (1) Civil Engineering

Works; (2) Structural Steel works (ref. 146).

The formula method of reimbursement uses indices related to twelve categories (resources) as listed in figure (9.8). The Consultant Engineer allocates the work into these twelve categories when preparing the tender documents, these are called "The Engineer Assessments". He does this by giving percentage value to each of these categories (resources) as proportions of the contract value.

At each valuation, the percentages given in the tender documents are applied to the total amount of the valuation and deducting the amount of the non-adjustable elements which is usually 10% of the measured work, because they will not get paid for, by any increase in prices. These non-adjustable elements are (ref. 146):

- provisional sum for work to be executed at current rates (i.e. daywork);
- articles manufactured abroad;
- provisional sum for nominated subcontractors and suppliers together with main contractor's profit;
- any work which is valued at current prices and rates;
- unfixed materials and goods on site;
- any sums paid to be contracted for reimbursement of direct loss and/or expenses;
- any other sums payable by the employer which are based on the actual costs incurred by the Contractor;
- credits allowed by the Contractor for old material

Item/Resource	Designation
1. Labour and Supervision	LA
2. Provision and use of Civil Engineering Plant, and vehicle etc.	PL
3. Aggregates	AG
4. Brick and clay products generally	BR
5. Cements	CE
6. Cast iron products	CI
7. Coated roadstone for road pavements and bitumenous products generally	CR
8. Fuel for plant generally (Derv)	FD
9. Fuel for plant generally (gas oil)	FG
10. Timber generally	IS
11. a) Steel for reinforcement b) Metal sections	
12. Fabricated Structural Steel	SS
13. Steelwork Labour	SL

FIGURE (9.8); THE RESOURECES USED IN THE FORMULA METHOD OF REIMBURSEMENT FOR CIVIL ENGINEERING CONTRACTS

- arising from the work;
- elements weighted by the Engineer.

If the non-adjustable elements percentage is 10%, then the recovery by the Contractor would be 90%, therefore, each percentage would be multiplied by 0.90 to give the coefficient for the category.

The "Price Adjustment Formula of Civil Engineering Contracts" pamphlet (ref. 147) explains the method of using the Adjusting Formula in the Civil Engineering contracts.

The Current Indices are published by HMSO in monthly bulletins under the auspices of the NEDO (ref. 74) and can be provisional as the collection of information to compile the indices takes a considerably long time and effort to obtain accurate indices, and are made "Final Indices", when sufficient information is available and the calculations have been performed. It may take up to three months for a Provisional Indices to be finalized (ref.135).

The "Base Month Indices" are the indices which are applicable to the date, 42 days prior to the date for return of tenders; "Current Indices" are the final indices which are 48 days before the last day of the period to which the certificate relates.

9.5.2) Price Fluctuations Handling on Site Manually

There is a list of procedures required from the Contractor to follow in order to get paid according to any

changes in the price of the materials and plant. These procedures might differ from one contract to another depending on the type of the contract (if it is a Civil Engineering, Building or International contract) as follows:

i) For Building Contract

According to the JCT 80 Standard Form of Building Contract (ref. 143), the following procedures have to be observed:

- 1) Contractor gives a written notice to the Architect when any fluctuation occurs on site;
- 2) The written notice to be given within a reasonable time, and it is a pre-condition for payment to be made;
- 3) The Quantity Surveyor and the Contractor will agree the net amount of the fluctuations;
- 4) Number (3) is dependent upon the Contractor submitting documentary evidence as required to enable the amount to be computed, both on his own behalf and that of his domestic subcontractors. This information to include a weekly certification of the evidence;
- 5) The net amount to be added to, or deducted from the Contract Sum, paid by inclusion in Interim Certificates and not subject to any profit that the Contractor has included in his Contract Sum.

The calculation of the net amount of the price fluctuation from applying "Building Formula" is expressed before.

ii) For Civil Engineering Contract

After the occurrence of the events which caused changes in the prices of the materials or plant, the Contractor shall give the Engineer notice thereof. The Contractor shall submit to the Engineer with his monthly statements, full details of every addition or deduction to be made in accordance with this event. According to this evidence or records, the net amount of any decrease or increase shall constitute an addition to or deduction from the sums, otherwise, payable to the Contractor under the contract after it has been calculated by using the "Baxter Formula" which has been expressed before.

iii) International Contract

According to FIDIC Contract Conditions (ref.129), clause (70), the Contractor has got to notify the Client in respect of any rising or falling in the costs of labour and/or materials or any other matters affecting the cost of the execution of the works after the date thirty days prior to the latest date of submission of tenders for the works. This note from the Contractor shall be certified by the Engineer and shall be paid by or credited to the Employer and the Contract Price adjusted accordingly.

There is no formula for calculating the Price Fluctuation of International contracts. What is being used on site for such contracts is calculating the difference in the agreed prices and paying it to the Contractor at the valuation as net amount.

9.5.3) Computer-Aided Price Fluctuation By Using "PLUS COST"

To get more accurate figures of the actual value of the work done from the site to be used in the comparison against the estimated figures for the reconciliation and feedback purposes. These figures are required to be adjusted according to the site practices which might occur on site. One of them is the Price Fluctuation (as explained before in this chapter). If this facility is available in the Valuation System such as; PLUS VAL (ref. 62), in this case, "PLUS COST" will get the valuation data accessed from such a system already adjusted for price fluctuation, and there will be no need for this option in "PLUS COST". However, this facility has been added to "PLUS COST" for adjusting the value of the work executed, so that the following two objectives will be achieved:

- 1 - The value of the work done will be adjusted for the Price Fluctuation before using it in the reconciliation and feedback reports. This facility is used in case this value has been accessed from a Valuation System that does not have the facility of adjusting the actual values for price fluctuations, or there is no Valuation System available to access the valuation data from. The valuation data will be entered manually to "PLUS COST" without any adjustment for price fluctuations and "PLUS COST" will do the price fluctuation adjustments automatically within the program before using this data in the system for controlling the site;

2 - In calculating the variation orders through "PLUS COST", as well as the measurements on rates already existing on the BoQ. "PLUS COST" will adjust these calculations automatically for Price Fluctuations before adding them to the valuation to produce the reconciliation and the feedback reports whenever it is found that BoQ items are subject to the price adjustment.

In the available site management systems, the price adjustment facility either does not exist or the values are adjusted manually before being entered into the system. This has made these systems inefficient. In controlling the construction site (ref. 57). PLUS COST by achieving the two objectives above of the price fluctuation will be the first integrated site management system which considers this site practice in controlling and managing the construction site by adjusting the site value/cost according to this practice before being used in the cost/value reconciliation.

The adjustment of the actual value for price fluctuations is applied on Contractor's and Subcontractor's value.

Figures (9.9 and 9.10) shows the "PLUS COST" inside procedure for the "Price Adjustment" facility for both types of contracts, Civil Engineering and Building respectively.

"PLUS COST" has been designed to achieve "Price Fluctuation" of the actual value of the work done by using two different methods,

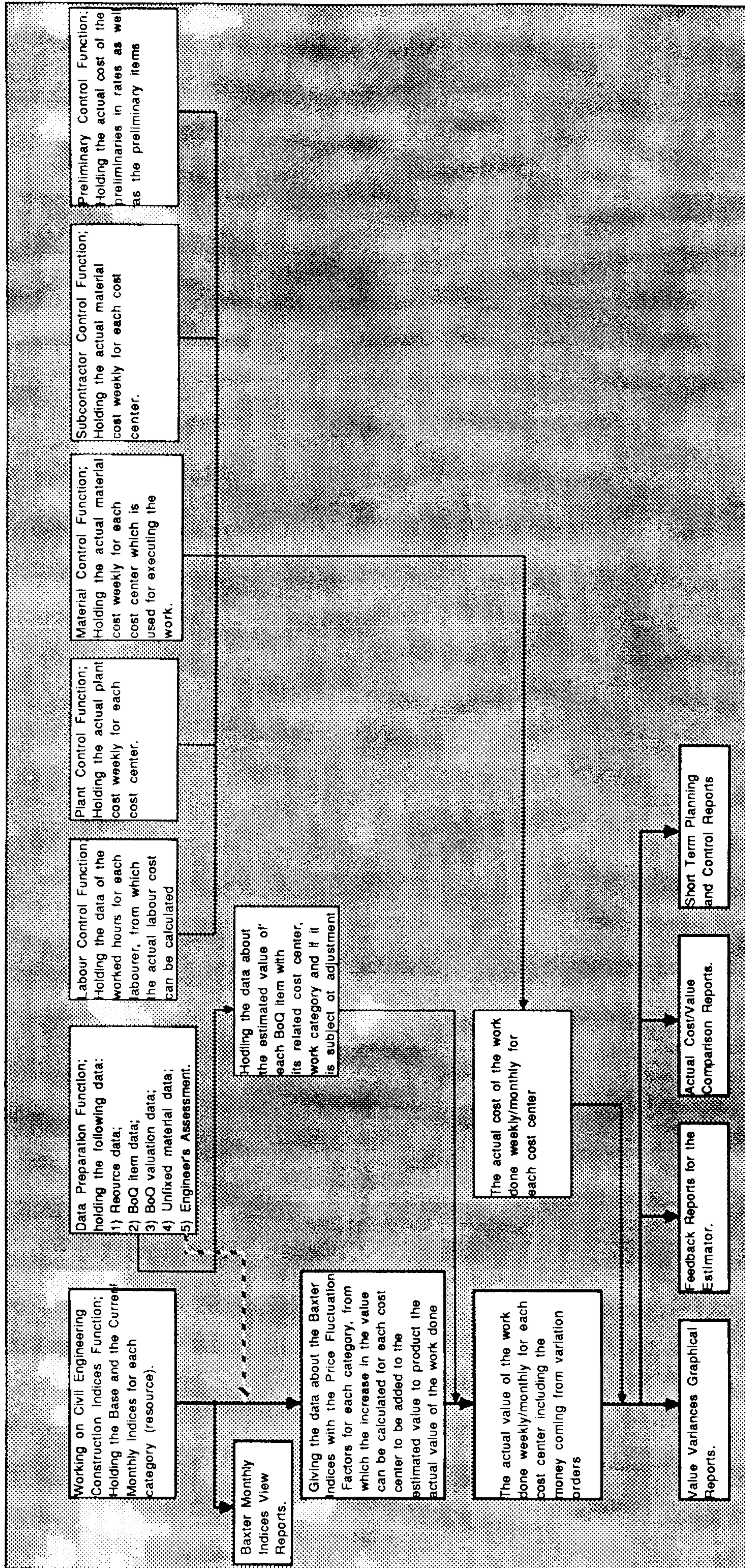


FIGURE (9.9); "PLUS COST" INSIDE PROCEDURE FOR "PRICE ADJUSTMENT" FACILITY FOR CIVIL ENGINEERING WORK

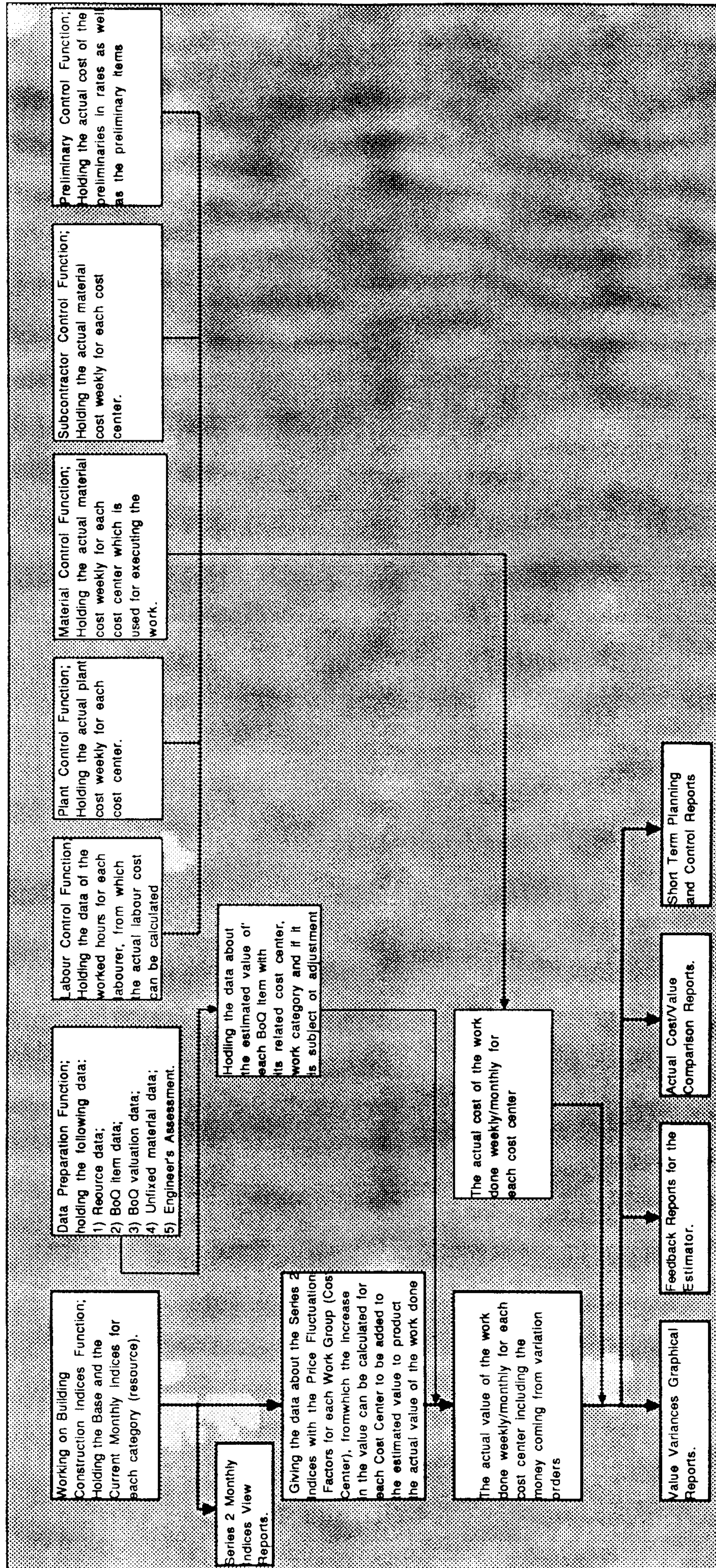


FIGURE (9.10); "PLUS COST" INSIDE PROCEDURE FOR "PRICE ADJUSTMENT" FACILITY FOR BUILDING WORK

depending on the type of the contract and the formula used. So that the using of this facility through "PLUS COST" also varies as follows;

1) For Civil Engineering Contracts

The use of the "Price Fluctuation" facility through the PLUS COST system can be divided into two parts:

- a) Editing and maintaining Baxter Indices;
- b) Applying price adjustment on required measurements.

a) Editing and Maintaining Baxter Indices

Once the user has entered the system, a list of five headings will appear on the screen, one of them is "To Work On Civil Engineering Indices". If this option has been selected, the user will be prompted to:

- i. Enter Base Month Indices;
- ii. Maintain Baxter Indices.

1) Enter Base Month Indices

Through this option, the user will be prompted to enter the basic month index data. On which the price fluctuation will be calculated later, this data is:

- Indices Date;
- Work Category Number;
- Indices Figures.

After the figures for all the thirteen indices have been entered, the system will display the entered data for any amendment

before the system will file the data in the "Indices Data File" to be used then in the calculation of "Price Fluctuations" for Civil Engineering Contracts.

ii) Maintain Baxter Indices

This option prompts the user to enter the monthly "Baxter Indices" and to amend them (if they are not final), whenever required. The way of entering the data is the same as in the previous option "Enter Base Month Indices".

If the amendment is required, the user can answer "NO" on the question "is it a new indices ?", and then "PLUS COST" will show the Baxter Indices of that selected month and give the user an option to do any amendment or updating on the indices.

b) Applying Price Adjustment on The Measurements

This is the second part of the "Price Fluctuation" facility for Civil Engineering Contracts. In this part, the user first has to enter the weighting factors (Engineer Assessment). He does that by giving percentage values to each of these categories. These percentages must be entered through the first option of the "Main Menu", as explained in chapter four if not already accessed from the Estimating System.

After it has been ascertained that these Engineering Assessments (percentages) have been filed into the system, the system will achieve "Price Adjustment" automatically by using the "Baxter

Formula" every time it calculates the actual value of the quantity executed for each BoQ item which has been entered as subject to price fluctuation. The system will display the net amount from this fluctuation in the reconciliation and feedback reports under the inflation column to be added to the actual value with the other adjustments to produce the gross value of the work executed.

ii) For Building Contracts

The facility of "Price Fluctuation" for Building Contracts, is also divided into two parts:

- a) To work on "Series 2" Indices;
- b) To apply price adjustment calculations.

a) To Work On Building Construction (Series 2) Indices

The user can select this function which is one of the five options in a list of headings. Through this option, the user can:

- i. Enter Base Month Indices;
- ii. Maintain Series (2) Indices.

i) Enter Base Month Indices

The way of using this option is similar to the option "Enter Base Month Indices" for Civil Engineering Contract, except the data required to be entered in is:

- Indices Date (Month, Year);
- Work Group Number (must be similar to the Cost Center);
- Work Category Number;
- Index Figures;

As explained before, "PLUS COST" has been developed to consider the Cost Centers as Work Groups for the Price Adjustment which will simplify the calculations in the system as well as the data entry by the user.

ii) Maintain Series (2) Indices

Through this option, the user will be prompted to enter:

- Indices Date (Month, Year);
- Work Group Number (similar to the Cost Centers Numbers);
- The data about the involved categories are:
 - * Category Number;
 - * Indices Figures.

After all the data for that Work Group has been typed in, an option of making any amendment will appear on the screen, otherwise, the system will go to the next Work Group, till all the groups have been entered.

Also through this option, the user can maintain any month indices by typing the required month date.

b) To Apply Price Adjustment Calculations

Once the "Base Month Indices" have been entered, "PLUS COST" will do the required calculations to produce the "Work Group Weighted Indices for a base month". These

calculations will be as follows:

- from knowing the BoQ items' category numbers (which is supposed to be entered with the item data through "Data Preparation" option or accessed from the Estimating package). These items will be grouped into their Work Groups according to their work categories, to find the totals for the work groups.
- from knowing the Base Month Work Category Indices, the Work Group Factors can be calculated for each work category by dividing the total for each work category by its Work Group Total.
- these factors (Work Group Factors) will be used to calculate the Work Group Weighted Indices as a result of multiplying the factors for each work category by its index figure of that valuation month, and the total of these multiplications for the work categories of each work group will produce The Work Group Weighted Index for that work group in that month.
- from the valuation of the work executed, the total actual value for each cost center (which is supposed to be Work Group) will be calculated and multiplied by its Work Group (Cost Center) Weighted Index to produce the "Gross Value" of that cost center.
- these Gross Values will be used to find the net amount of price fluctuations.

All the above calculations will be undertaken within "PLUS COST".

The Work Group (Cost Center) factors will be filed through the system ready to be used with any valuation to produce the actual gross value of the work executed for each cost center, these values will be used in producing the reconciliation and feedback reports which have the gross values of the work done including the price adjustments.

The data entry of Price Adjustments for both Civil Engineering and Building Contracts are shown in detail in Appendix Q, figures (1-8).

From the description of how "PLUS COST" can assist in calculating the value of the price fluctuation at each valuation to be added to the actual value of the work done . It is expected to be the first system that has achieved the requirements of an efficient computer-aided on-site price adjustment calculation system, as part of a site management system.

9.6) SUMMARY AND CONCLUSION

The following points are a summary of the work done through this chapter and a conclusion of it.

- 1) The site management is influenced by some of the site practices such as; claims, variation orders, dayworks and price fluctuation. These practices produce unexpected sums which will influence the actual cost/value figures and make the required adjustment accordingly before

being used in controlling the construction site and producing the control and feedback reports.

- 2) There are many computer-aided valuation systems which have been developed to control the site practices (registration and measurements) for the purpose of interim valuation of the Contractor as in PLUS VAL (ref. 62).
- 3) So far, all the available site management systems are controlling the site without concerning these practices, and that is one of the reasons that made these systems inefficient. PLUS COST is the first computer-aided site management system that has considered these practices in its site control operations.
- 4) To use this function, PLUS COST will first calculate the actual cost of the work done and calculate or access the actual value from the valuation system. The actual cost/value is then adjusted accordingly to these practices before being used in producing the control and feedback reports.
- 5) The adjustment is achieved by PLUS COST which will calculate the values of these practices within the system from the measurement data. This data can either be accessed from the valuation system (as PLUS VAL (ref. 62)), or entered manually into PLUS COST through this facility
- 6) Having adjusted the actual cost/value figures according to these practices, the figures will then be more

accurate in the control and the feedback reports, and that will make the site control more efficient.

- 7) In addition to adjusting the site figures, "PLUS COST" uses this function to produce on-screen reports to assist the Contractor in his controlling and evaluating these practices on site.

At the end of this chapter and from the description of the work done in the last chapter, "PLUS COST" has achieved all the requirements of costing the site work and controlling the resources and is now ready to produce the control and feedback reports for the site management purposes as will be explained in the next chapters

CHAPTER TEN

CHAPTER TEN

FEEDBACK OF CONTROL RECORDS

10.1) INTRODUCTION

In designing and using a cost control system, it is important to keep in mind the main purposes that such a system serves, one of them is: to provide the relevant feedback, carefully qualified in detail by all the conditions under which the work has been carried out, to the Estimator who is responsible for establishing the standards in the past and the future (ref. 5). The feedback of site control records is also required by the other management personnel such as Planner, Office Manager, etc., so that the estimates and the plans will be updated and the corrective actions may be ordered on the site to overcome any uneconomic indication that may appear.

Achieving the feedback by any site management system required data integration between the system and the other construction management systems of; Estimating, Planning and Valuation. Such integration will allow the control data to flow back from the site to the Estimator and the other management personnel.

In my research survey of construction companies, I have identified that the feedback in these companies are still very simple and mainly given to the Estimator by using historical site data. My

other survey on current site management software showed the software that are still unintegrated cannot access the site control data back to the other management systems (as explained in chapter three).

However, this chapter describes this aspect (Feedback) as the last main objective of the research, by explaining its definitions, the necessity of feedback reports to the key project personnel, the manual methods used on site and then how "PLUS COST" as an integrated computer-aided site management system has achieved this aspect of "Feedback" and provides the required feedback for project personnel, both on and off the site.

At the end of this chapter and from the work done through it, I have achieved the last main objective of this research which was; "developing an integrated computer-aided site management system which can assist in passing the resulting data back to the Main Office from the site as feedback process"

10.2) DEFINITIONS OF FEEDBACK

The dictionary defines "Feedback" as; "return to input of part of output of system or process". In the Management, "Feedback" is defined as (ref. 157); " the process of sending back the information to the original. This information will be compared against the expected ones to keep the operation within their expected limits".

The Construction Industry defines the Feedback facility as (ref. 8); "sending the site (the actual) information back to the origin (e.g. Estimator or Planner) to be compared to the estimates and plans, and put the reasons behind any losses or bad performance". This process of feedback is essential, because from these comparison reports, it would be possible to compare the actual with what was planned, and may lead to a decision whether corrective action is required or not. These reports are also required for updating the estimating figures and the project plan according to the actual site data to achieve better usage of the project resources.

From the above three definitions, I can define the Construction Management Feedback as; "the process of return to the input resource of part of the output data of the site management system. This returned data will be compared to the input data, so that the construction operations of uneconomic indication or bad performance can be identified. Corrective action may then be ordered by the management on these operations".

10.3) THE NECESSITY OF FEEDBACK

Feedback is of a control cycle in which decisions are made regarding performance against the targets as shown in figure (10.1). It is therefore, from this point that corrective action is initiated to adjust any of the factors within the enterprise. From this point of view, feedback is essential and

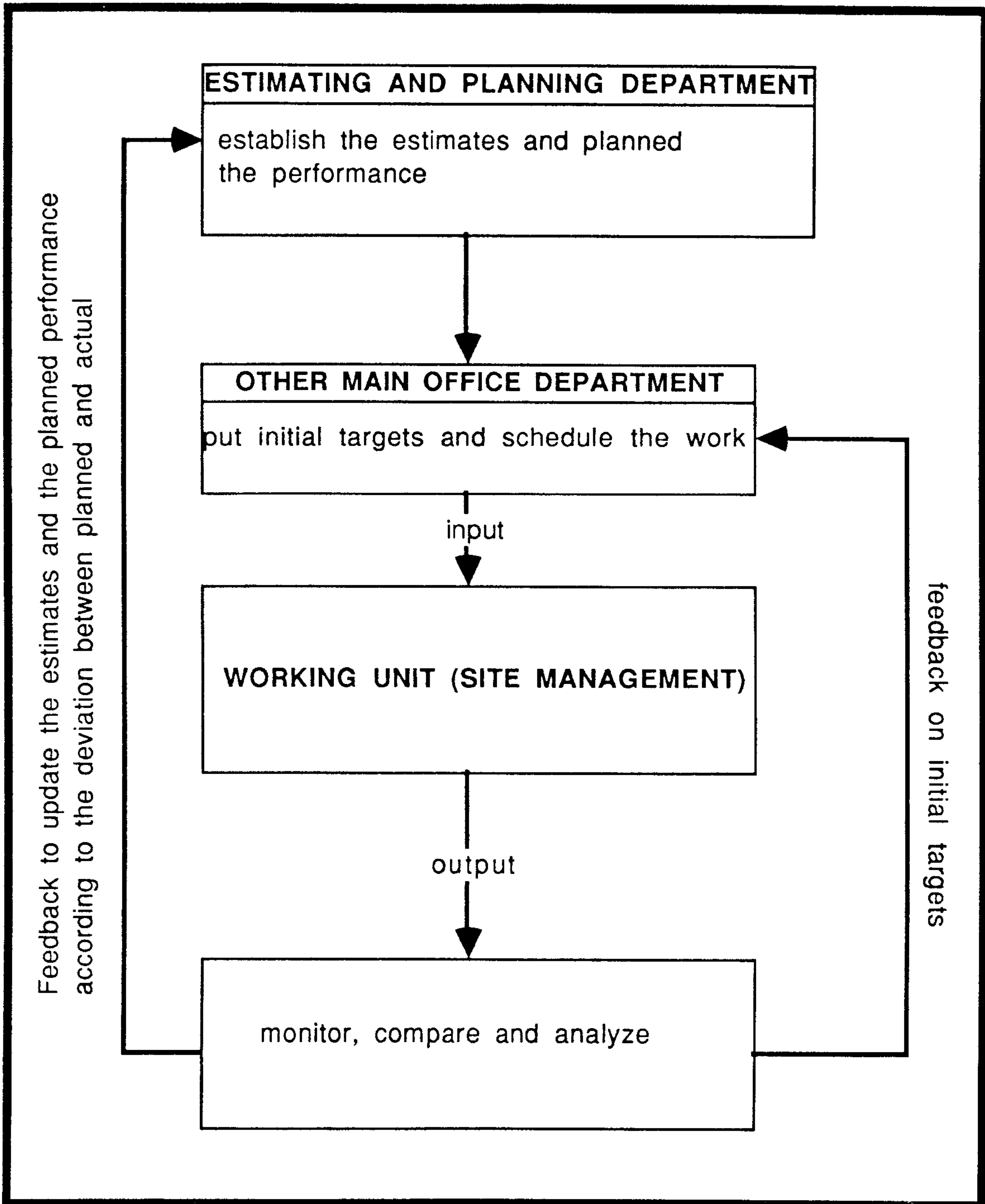


FIGURE (10.1); THE FEEDBACK CIRCLES IN THE MANAGEMENT CONTROL CYCLE

demanded by all the key project personnel on and off site according to his responsibility for keeping the actual figures of cost and performance within the planned figures.

Feedback is usually directed to the estimator who requires full information regarding costs and the conditions under which the correct activities are carried out. So that the project budget can be updated for any future estimates.

In my research survey of the literature and construction company requirements, I have identified that the feedback process can be more important to the other key personnel on/off site than to the estimator. Those key personnel will use the feedback data in controlling the work cost and progress and keep the work within the plan according to the role of each personnel in controlling the project.

The following is a brief description of the duties of each department of the Main Office and the necessity of feedback data to them. The duties of the on-site personnel and their requirements for the monitoring and controlling reports as feedback from the lower personnel, as shown in figure (10.2), are explained in detail in chapter eleven. The off-site departments' benefit from on-site feedback reports according to their duties as shown in figure (10.3) are as follows:

Purchasing Department is responsible for obtaining the lowest

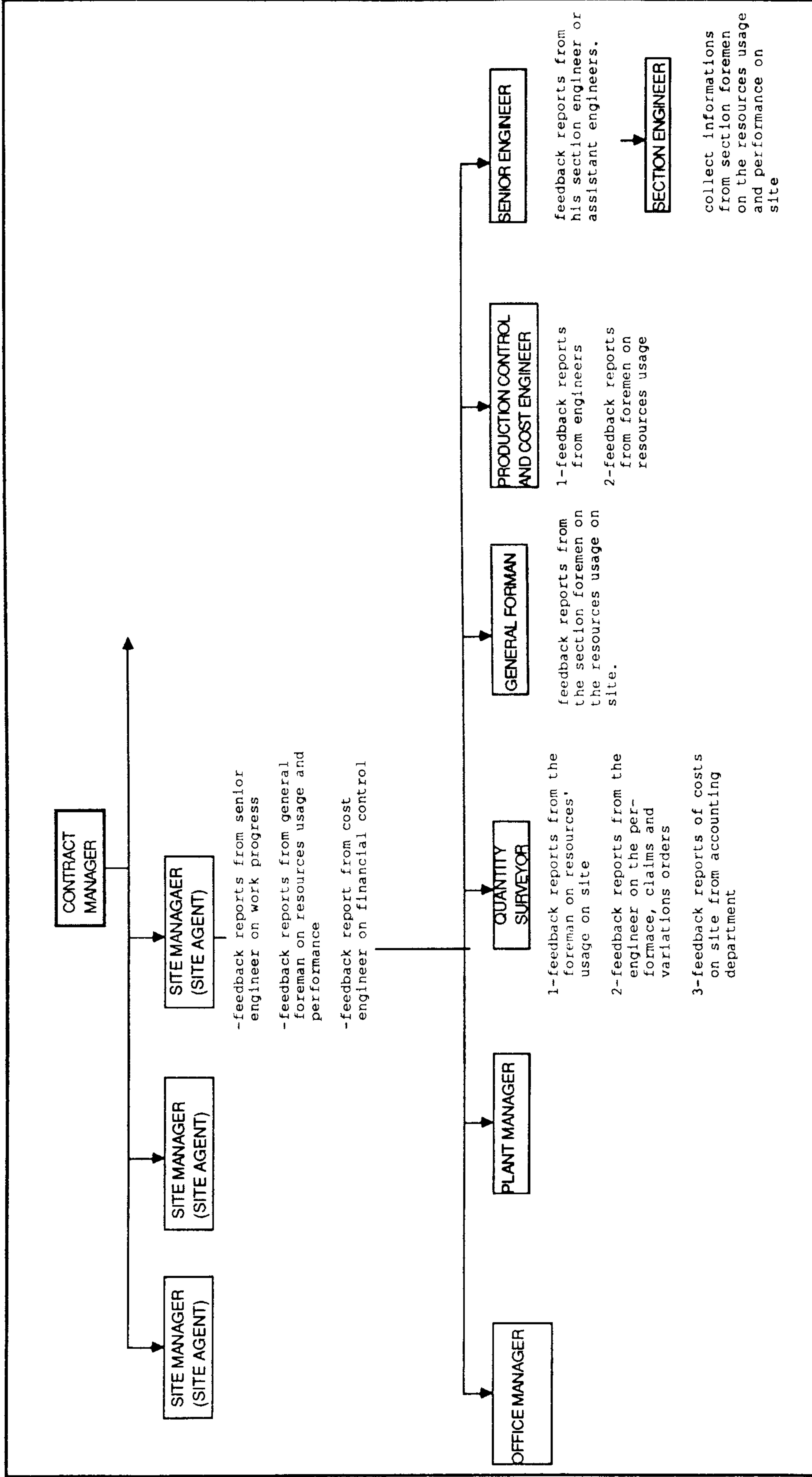


FIGURE (10.2); THE ON SITE CONSTRUCTION ORGANIZATION REQUIREMENTS FROM THE FEEDBACK FACILITY IN ANY SITE MANAGEMENT SYSTEM

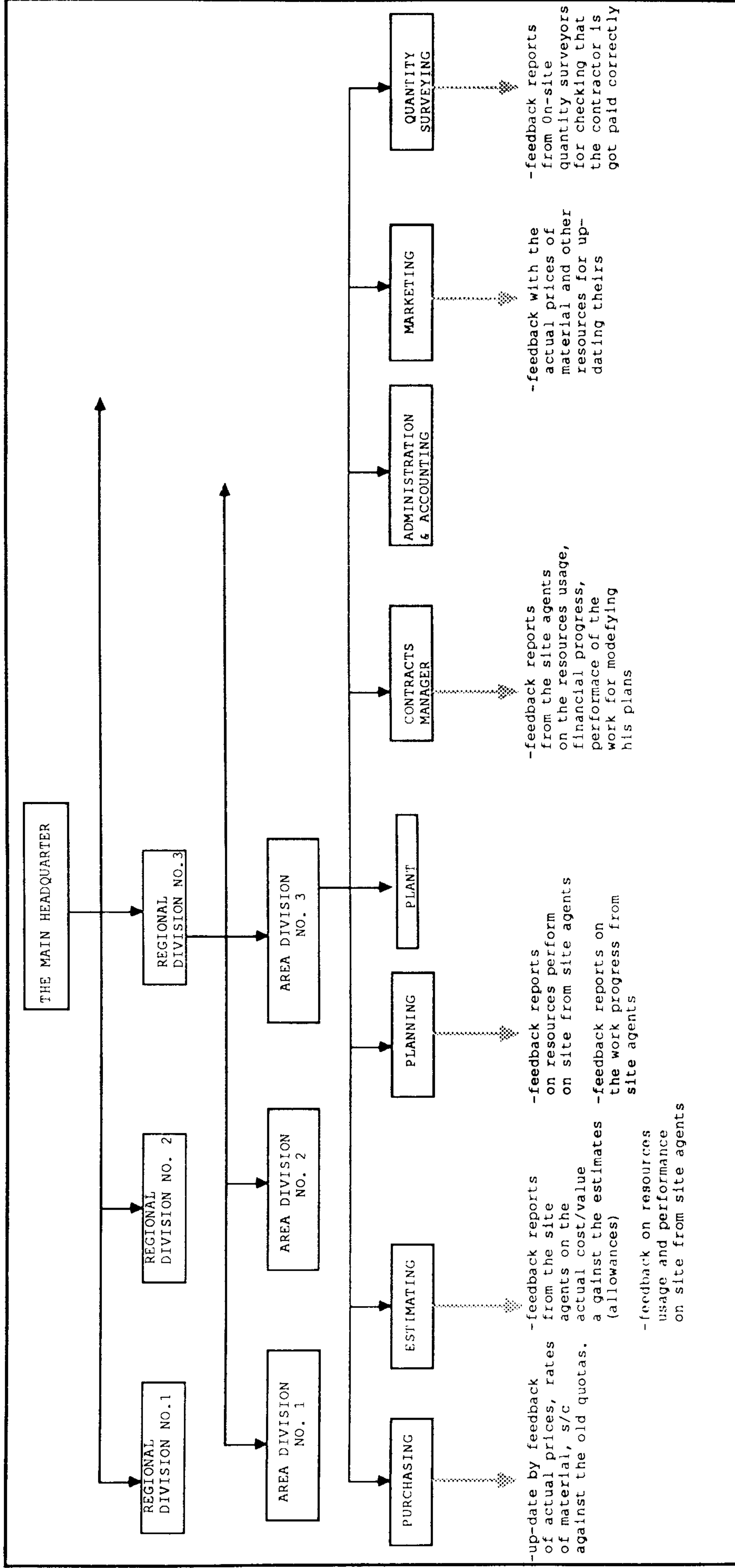


FIGURE (10.3); THE OFF SITE CONSTRUCTION COMPANY'S DEPARTMENTS REQUIREMENTS FROM FEEDBACK FACILITIES IN THE SITE MANAGEMENT SYSTEM

subcontractor and material quotas for the required material and subcontract and for keeping price lists updated. So that, it requires to be informed about the actual updated prices of the materials that are delivered or purchased from the market in order to up-date their price lists.

Estimating Department (Estimator) is the main user of the Feedback as it is his responsibility to put the allowances for resource rates, pricing the tenders and giving allowances for material wastages and utilization on site. From the feedback data, the Estimator can compare his estimates by re-estimating the resource's rates and putting in better figures for any future projects of a similar nature.

Planning Department's main responsibility is to plan the tender for the most economical way of doing the job within the required time. So that it usually asks to be provided with information back from the site telling if there are any delays in executing the work and the reasons behind them. The department will use this data to update the project plan by either correcting it or re-planning the work again for the coming period of time (if necessary).

Contract Manager manages all the company's contracts as they are planned to be executed on site. He requires reports on the progress of the work, as comparison reports, from the Site Agents (Site Managers) attached with their comments as the reasons behind any uneconomic indications or delays in executing the work.

The corrective action may be ordered by him (if necessary) depending on these reports.

Marketing Department will get benefit from the feedback information indirectly, as it is responsible for setting the enquiries for tendering purposes. The benefit comes by updating its information on prices and marketing whenever changed and then it will provide the Estimating Department with updated prices to be used in pricing the tender.

10.4) MANUAL OF FEEDBACK METHOD OF THE SITE DATA

The Estimator will build-up the estimates (allowances) for executing the project activities according to their resources. The planner, through the Planning Department, will put the plans for the project progress and resource usage within the time limits to get the required performance of the resources on site to do the work within the required time with maximum expected profit. These allowances and plans are used then by the on-site key personnel as well as Main Office Departments to put their in own plans, which should match with the overall project one to control and monitor their areas according to their role of controlling the project (as explained previously in this chapter).

While the work is executed, the weekly cost of the work done will be calculated from the collected site resource data (labour and

plant) collected for each activity (cost center). The key site personnel will fill up and prepare the "Feedback Record Sheet" figure (10.4) and sent it to the Estimating and Planning Departments at the Main Office (they may send the site data by using what is called "Historical Feedback Record" figure (10.5)). These records or reports will then be used for controlling the project financially and forecasting the project cost for the next period of time. These feedback reports will also be used to indicate any delays caused from bad usage of the resources. So that work will be re-planned for the coming period and the resources will be re-allocated for a better usage accordingly.

This site data may take a very long time to reach the Main Office Departments and that makes the data which is sent back "historical data" which can be used only by the Estimator for the future estimates.

10.5) THE REQUIREMENTS OF AN EFFECTIVE FEEDBACK

As I have mentioned before in this chapter, obtaining feedback from the output and comparing it with the estimating cost/value figures and planned performance levels is an essential feature of the control process. But there needs to be an adequate feedback on progress and expenditure to let the work team work together to exercise control and design corrective action for any probable occurrence.

A list of points must be considered to achieve such an adequate

<u>CONTRACT</u> <p style="text-align: center;"><u>FEED-BACK RECORD SHEET</u></p>							
Standard Value	£125		£150		£75		
ITEM	Excavater Footings		Concrete Footings		Brickwork to D.P.C		
WEEK NO.	NO.	HOURS	NO.	HOURS	NO.	HOURS	

FIGURE (10.4); A SAMPLE OF FEEDBACK RECORD SHEET USED ON SITE FOR HOUSING CONTRACT

SITE/ESTIMATING DEPT. COPY

HISTORICAL FEEDBACK RECORD

W/E	ACCUM. ACTUAL MEASURE	BONUS	LABOUR	PLANT	TRANSPORT	TOTAL COST	UNIT COSTS		MAN HOURS EMPLOYED	PLANT HOURS EMPLOYED									
							LAB.	PLANT											

FIGURE (10.5); THE HISTORICAL FEEDBACK RECORD SHEET WHICH IS USED FOR FEEDBACK ON SITE

and effective feedback. These points are:

- 1) Good Communications management; which can provide the feedback reports as quickly as required, so that the corrective action will be taken effectively according to these reports.
- 2) Good presentation; from knowing by whom the feedback reports are going to be used and for which purpose. These reports can be presented in a way to show carefully in detail the control figures with the reasons behind any unacceptable results.
- 3) The required level of details; to achieve the requirements of all the management personnel from the feedback reports. Different levels of detailed feedback reports require to be provided to cover all of these requirements from the feedback.
- 4) The accuracy; to provide feedback reports which are as reliable as possible, the actual figures of the reports must be very accurate. So that the controlling procedure will be quite effective and efficient in identifying the uneconomic operations or the resources of bad performance.

10.6) COMPUTER-AIDED FEEDBACK OF THE SITE DATA BY USING " PLUS COST "

To achieve an efficient site management, every project personnel (on/off the site) must be fully informed of

what is happening on the site and provided with site reports which show the planned figures against any uneconomic indication. I have identified from my survey on the construction company systems and the survey on the available software that there is no sign of an efficient feedback operation of the site data. The company's site management systems available either do not have the facility of feedback at all, or they produce comparison reports which are then used for producing feedback manually. All the attempts of developing computer-aided feedback site data could not reach further than feedback to the Estimator a historical list of site data (data base) with no indications or comments. That makes the available systems still inefficient in achieving feedback function on site.

In developing "PLUS COST", as an integrated and efficient computer-aided feedback of site data as part of site management, the following points have been considered:

- 1 - good understanding of the necessity of the site feedback;
- 2 - the duties of each project personnel (on and off the site) in controlling the construction site;
- 3 - the data requirements of those personnel from the site feedback;
- 4 - the possibility of the data integration between "PLUS COST" and the other management systems.

After the four points above have been identified and fully understood, the facility of the site control feedback has been developed in "PLUS COST" to fulfill the requirements of project personnel (on and off the site) in the efficient and effective feedback reports, and provide their demands from such reports (which have been identified in the chapter before).

"PLUS COST" through this facility works as an integrated system to the other management systems of Estimating, Planning and Valuation at the Main Office. Through this integration, the other management systems will be able to get any of the controlling reports on site (as explained in chapter eleven) in few minutes whenever required.

However, I have developed "PLUS COST" to achieve the objective of Feedback by providing two types of feedback reports. These reports are quite efficient and quickly provided by using terminals between the site and the Main Office Departments or by storing them on the computer disc to be used by the project personnel through his mini-computer.

This facility (Feedback) in "PLUS COST" is the first serious attempt that has achieved the site management and the construction management objectives in a more efficient and integrated procedure. These objectives are:

- 1 - having integrated site management, that

the site data passes between the site personnel;

2 - having a fully integrated management system, which can accept the data passes from the Main Office Departments of Estimating, Planning, etc. It will also send the data back to the same departments after it has been compared against the actual.

The achievement of the above objectives by providing two types of feedback reports through PLUS COST is explained in the following.

10.6.1) Estimator's Feedback

"PLUS COST" can provide separate feedback reports to the Estimator as one of the print out reports. In these reports, "PLUS COST" will show the budgeted figures of each Bill Item of any selected Cost Center with their total actual cost incurred on the site as well as the variances at the end of the reports. These reports can be provided for any selected valuation date.

The way of providing these reports is explained in detail in chapter eleven.

10.6.2) Other Key Personnel's Feedback

"PLUS COST" firstly will provide the required control reports printed out (in figures or graphs). The

site personnel will check these reports and those who are in-charge of uneconomic operations indicated in the reports, can add their comments as reasons behind these indications on the report by selecting "Feedback Comments" option from the system. Through this option, "PLUS COST" will ask for the following data to be entered:

- The Required report;
- comment's Date (the date that the comments are added);
- Personnel's Position on the Site (the position of the user on site);
- The Comments (this can be as a list of reasons, up to 20 different reasons).

The system will automatically add this data to the end of the required report. So that the upper level (on/off site) who asked for this control report to be fed-back to him, will get the reports as a comparison report (in figures or graphs) with the comments of the persons, who are in charge, at the end of any unacceptable indication that may appear. More than one list of comments can be added to the same control report by the same or different site personnel. Each set of the comments will have its date of addition and the position of the site personnel who added it on. The report with its site comments will be filed in the system to be provided whenever required.

The way of using this facility "Feedback" and their reports are shown in Appendix (R), figures (1-3).

10.7) SUMMARY AND CONCLUSION

The following points are a summary of the work done through this chapter and a conclusion of it.

- 1) Feedback is one of the main purposes of the site management system which is required to be considered in designing such a system.
- 2) Achieving such purpose required data integration between the site management system and the other management systems of Estimating, Planning, Valuation, etc. to allow the site data to flow back to the Main Office through this integration.
- 3) Feedback of site data is essential to all the key personnel of the project on and off site as much as the Estimator, the necessity of this process (Feedback) to each construction personnel depends on his role of controlling the project.
- 4) Feedback is either not available in these systems or it is provided to the Estimator only as a list of historical site data with no comments from the site on the data. This data is usually handed back to the Estimator manually because of no integration between the site management and the other management systems to allow the data to flow back to the other systems.
- 5) In developing this facility in PLUS COST, four points have been considered:
 - a) good understanding of the necessity of the site feedback in construction management;

- b) the duties of each project personnel (on/off the site) in controlling the construction site;
 - c) the data requirements of those personnel from the site feedback;
 - d) the possibility of the data integration between PLUS COST and the other management systems.
- 6) Feedback function in PLUS COST can provide two types of reports. Firstly "Feedback Reports to the Estimator" as one of print-out reports of the system. Secondly, using any of the monitoring and control reports to send it back to the other management systems after giving an access for the site personnel who are in charge of uneconomic operation to add their comments at the end of the reports.
- 7) "PLUS COST" through this function (Feedback) has achieved the efficiency requirements by providing:
- a) very quick reports (in minutes) and whenever required;
 - b) different level of detailed reports to give a better chance of selection between them as required;
 - c) carefully qualified in detail reports of different presentation to achieve the construction company's requirements;
 - d) accurate reports which have all the figures

that are calculated by the system. The only mistakes might happen in typing in the data, and this is also reduced by providing a checking facility which checks if the entered data is logically accepted by the system.

- 8) This achievement of PLUS COST is expected to be a big step in the use of a computer-aided system for providing an integrated and efficient construction management system in the construction industry.

At the end of this chapter and from the work done through it, I have achieved, for the first time, the promise of developing a computer-aided feedback of the site data as part of a site management system. This feedback facility has fulfilled firstly the demands of all the project personnel (on and off the site) from efficient feedback reports. Secondly, the required integration in the management data through the site personnel, and between the site and the other construction management departments at the Main Office.

Having fulfilled this promise I will have achieved the third main objective of this research.

CHAPTER ELEVEN

CHAPTER ELEVEN

PROVIDING SITE MANAGEMENT STATEMENTS ON SITE

11.1) INTRODUCTION

In any system of site management, the aspect of reporting must receive a great deal of consideration in order that only the correct matters are reported to the right person in a simple and understandable format. The purpose of the report in the Site Management System as described by Dutton (12) is; "to provide a sound basis for management decisions by showing deviation from or compliance with the adopted plan or budget". In order to accomplish this purpose, the report must (ref. 12):

- portray the facts accurately;
- cause management to carry out whatever action is necessary.

The point to be stressed is that an effective system of reporting communicates information and that means much more than producing pages and pages of figures for management to dissect and interpret.

This chapter describes the above aspects as it is the last part of "PLUS COST" achievements of "Business Requirements" specification for an efficient and integrated site management

system.

In this part, "PLUS COST" has been developed to be used as an integrated computer-aided site management system provides control and feedback reports and statements for all the responsible people on site and at Head Office.

The chapter has been divided into three parts. The first part explains the aspect of reporting by describing the principles of reporting, the general relationships between the project personnel and the control reports, and the reporting methods used. The second part describes the construction organization on/off site with their needs from the control and feedback reports. The last part explains the achievements of "PLUS COST" as an integrated computer-aided system producing efficient site management reports on site, as part of a site management system.

From the work done through this chapter and as a conclusion of it, the part of the "Business Requirements" specification of an integrated computer-aided site management system concerning the provision of efficient control and feedback reports has been achieved.

11.2) SITE MANAGEMENT REPORTING

The evaluation of any site management system can be indicated from the reports produced through that system. So that to achieve efficient site management, a good and effective

reporting system is required, through which the required control reports can be produced.

This first part of the chapter reviews the principles of an efficient reporting system, the general relationships between the site personnel and the Main Office departments and the methods of reporting. From this review, the Reporting Requirements will be identified to be used in developing the reporting system in "PLUS COST" as an integrated and efficient computer-aided site management system.

11.2.1) Principles of Reporting

Financial facts and data to be reported to the management must be presented in a clear concise and forceful way, and also, at a time, to be of maximum use.

The Highway Research Board of the "America National Academy of Engineering" (155) carried out an exhaustive examination in the field of reporting and consider that a good report has the following characteristics:

- 1 - It contains all the essential facts of the situation reported without extraneous information or unnecessary details to waste the reader's time or confuse him.
- 2 - It is presented in a format which permits a quick and easy grasp of the essential information, and is expressed in terminology with which the reader is completely familiar.

- 3 - It permits the user of the reports to concentrate on exceptions by focusing attention on comparisons which highlight trends or deviations from target performances.
- 4 - It is timely, and, if routine, is produced on a regular schedule, so that executives may expect reports at specific times and rely on them.
- 5 - It is tailored to fit the requirements, personality, performances and capacity of the recipients as to format the amount of back-up detail, and other report characteristics.
- 6 - It shall be designed for eye-appeal, easy reading and easy reference.
- 7 - It shall be supported by appropriate analysis of the financial information supplied and shall be accompanied by significant summaries.
- 8 - It shall be sufficiently useful to justify completely the time and cost involved in its preparation and presentation.

The above characteristics have been considered in developing the reporting function in "PLUS COST" as will be explained later in the chapter.

11.2.2) General Relationships

In order to satisfy the above basic principles of reporting, it is necessary to know for what purposes site management needs the information. It is then possible to design

the report to cater for these needs.

If the reporting system is coordinated with the organization plan, then gaps or overlaps are avoided in the coverage of reporting by functions. It also allows each management personnel's attention (on/off site) to be directed to the information that is particularly relevant to that person's duties and responsibilities.

Related reports must be carefully coordinated and their relationships should be made clear for easy reference. The reporting system should be so organized that the user of these reports learns of the financial effects of decisions made as a result of the reports. He can then, in turn, provide reports of the results of these decisions.

All the pertinent facts must be presented in such a manner that important data and relationships are clearly set forth and emphasized, and, as far as possible, information should flow from one part of the statement to the other.

The report must be designed to provide for comparisons, the yardsticks for evaluation of progresses and costs. Excessive detail only obscures significant facts and relationships and, may, in fact, delay the report completion to the extent of affecting its timeliness for management.

If the report is intended for action, as the Cost Status report may

well be, rather than as historical record, figures should be rounded to significant digits, so that the reader's mind is not cluttered unnecessarily.

The relationships within the construction personnel and the site management reports and their demands of these reports have been investigated depending on the above review (as explained in the second part of the chapter).

11.2.3) The Methods of Reporting

The site control and management reports are of written variety. It is required to review these varieties before deciding on the method of reporting the financial information in PLUS COST to make the form of the reports produced by the system helpful, necessary and even essential as required by the management on site. The following review explains the form of the reports that are in use on the subject of site management as computer output to present the financial information. From this review I have selected the method of reporting to be used for PLUS COST reporting system.

Whatever the type of reporting device used, the data should be lucid and ideas must be conveyed smoothly and rapidly.

The following are the methods of reporting the financial information as used by the management systems (ref. 12):

- i) Verbal Reports;

- ii) Narrative Reports;
- iii) Graphic Reports;
- iv) Conventional Financial Statements.

i) *The Verbal Reports*

There can be many occasions when this form of reporting to management is useful, necessary and even essential. Through this type of report, efforts will be made to present data in as lucid a manner as possible by a well-briefed presentation of the financial information. On such occasions, the user of the verbal report can clear up data difficulties very quickly and may be able to supply the answers to queries regarding the reasons why certain projects or parts of projects are not meeting schedules. The time required to identify the required information will be speeded up because the report user will usually know where to find this information and thus save considerable time in initiating corrective action.

ii) *Narrative Reports*

The use of narrative reports can be very effective for communicating financial information, especially in those situations where specific action has to be recommended.

The summarizing of detailed data, making comparisons and recommendations are also particularly suited to narrative reports

A clear and simple presentation is required for the narrative

report and the design of its detail should be such as to assist the manager to locate key points quickly without the necessity to back-track (ref. 12).

iii) *The Conventional Financial Statement*

These are the reports that are probably the most important in the whole cost reporting structure. They should normally be drawn up along the lines of professional acceptable accounting principles, and are designed to indicate results of operations and the situations that have developed from the operations.

In such a statement, it is very important that the details be designed for quick comparisons and that the data be organized into homogeneous groups. Summaries should be strategically placed, so that there is a natural flow from the data to them. This assists the reader in selecting the information which is his own concern.

iv) *Graphical Reports*

Graphics are used fundamentally to indicate comparisons in a visual form. They should normally be used as a supplement to other types of presentation. Relationships are more easily grasped and remembered, and associated problems are more easily identified with a clear graphical presentation at correct scale (ref. 12).

In "PLUS COST" I have used the last two methods of reporting in

developing the reporting system. The first method "Conventional Financial Method" is used to produce the comparison and the feedback reports through the system. While the second method "Graphical Method" is used to produce the subsidiary graphical control reports (as explained later in this chapter).

11.3) THE MANAGEMENT SYSTEMS OF CONSTRUCTION COMPANIES

In the first part of the chapter, the required principles as well as the methods for an efficient reporting system have been identified. Through this second part and before "PLUS COST" was developed to produce control reports for the construction personnel (on/off the site), it is required to understand the management systems of construction companies (both Civil Engineering and Building), on and off the site. From that, the reports can be produced to assist those who demand them for their site management purposes and that makes sure only the correct matters are reported to the right person.

The following are the most common management systems for both Civil Engineering and Building Companies on and off the site. These systems could differ from one company to another, but never the less, they have the same main departments. The management systems are (ref. 3):

11.3.1) Civil Engineering Construction Company

This review explains briefly the most common construction management system in the Civil Engineering companies (both on and off site) with the duties of each department/personnel. The general relationships have then been identified between the departments/personnel and their demands for the site management reports.

1) Off-Site Management Structure

For most of the large size construction companies, the management organization is usually headed by "Main Headquarters", from which the Regional Divisional will be divided. Each Regional Division controls and manages all the construction areas within the region. Therefore each Regional Division has many Area Divisions. Each Area Division will be considered then as a construction company itself in small size. Each Area Division will have its own construction management system which involves the following departments:

- Marketing;
- Estimating;
- Planning;
- Buying;
- Contracts Management;
- Quantity Surveying;
- Office Manager.

All the above departments and a brief description of their duties

are shown in figure (11.1). However, this construction organization structure can be varied from one company to another as they may have more or less departments, but in any case, these are usually the most common departments.

ii) On-Site Management Structure

Obviously, organization arrangements vary from one company to another, and with the size and type of each contract within the company.

The following organization is an example of the most common family tree to be found on the construction site. In this example, the following key personnel can be seen on the site:

- Site Agent (Site Manager);
- The Senior Engineer;
- General Foreman;
- Plant Manager;
- The Office Manager;
- Quantity Surveyor (Management Engineer);
- Planning Engineer;
- Safety Officer;
- Store Keeper;
- Chief Production Control and Costing Engineer.

On small jobs, the duties of some of the above personnel are combined. For example the Site Agent may also act as a Senior Engineer, the General Foreman may act as the Plant Manager (if

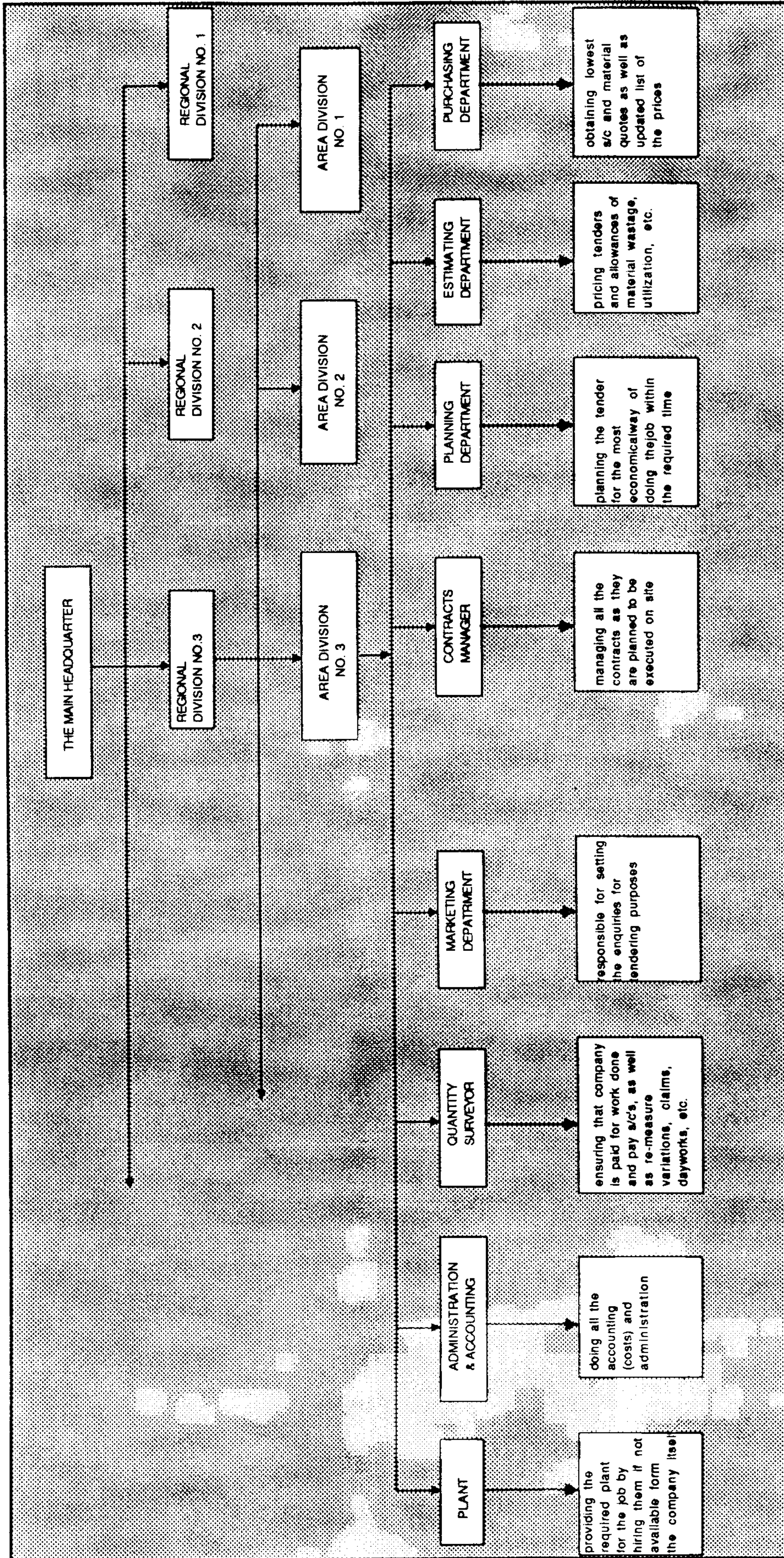


FIGURE (11.1.1); THE OFF SITE CONSTRUCTION COMPANY ORGNIZATION WITH THEIR MAIN DUTIES.

there is not that much plant on site). Also the duties of the Quantity Surveyor may be carried out by Engineers. The Office Manager may also be Head Time Keeper and so on. On large contracts, there may be several Site Agents. In this case, the Contracts Manager may appear. A brief description of the duties of all the above key personnel on site is shown in figure (11.2).

11.3.2) Building Construction Company

The off site organization structure for construction firms of Building works is quite similar to that of small firms of Civil Engineering works. On site, it is also similar to the on-site organization for small Civil Engineering contracts with the following differences:

- 1 - the duties of the Quantity Surveyor can be carried out by the Engineer;
- 2 - no need for Section Engineers;
- 3 - the Foreman can do all the jobs of the Plant Managers, Head Time Keeper and Safety Officer;

11.4) THE SITE MANAGEMENT REPORTS REQUIRED ON/OFF SITE

From knowing the duties of all construction personnel on/off site through the construction organization (for both Civil Engineering and Building Works), the requirements of those personnel for the site management reports (control and monitoring) from any site management system have been

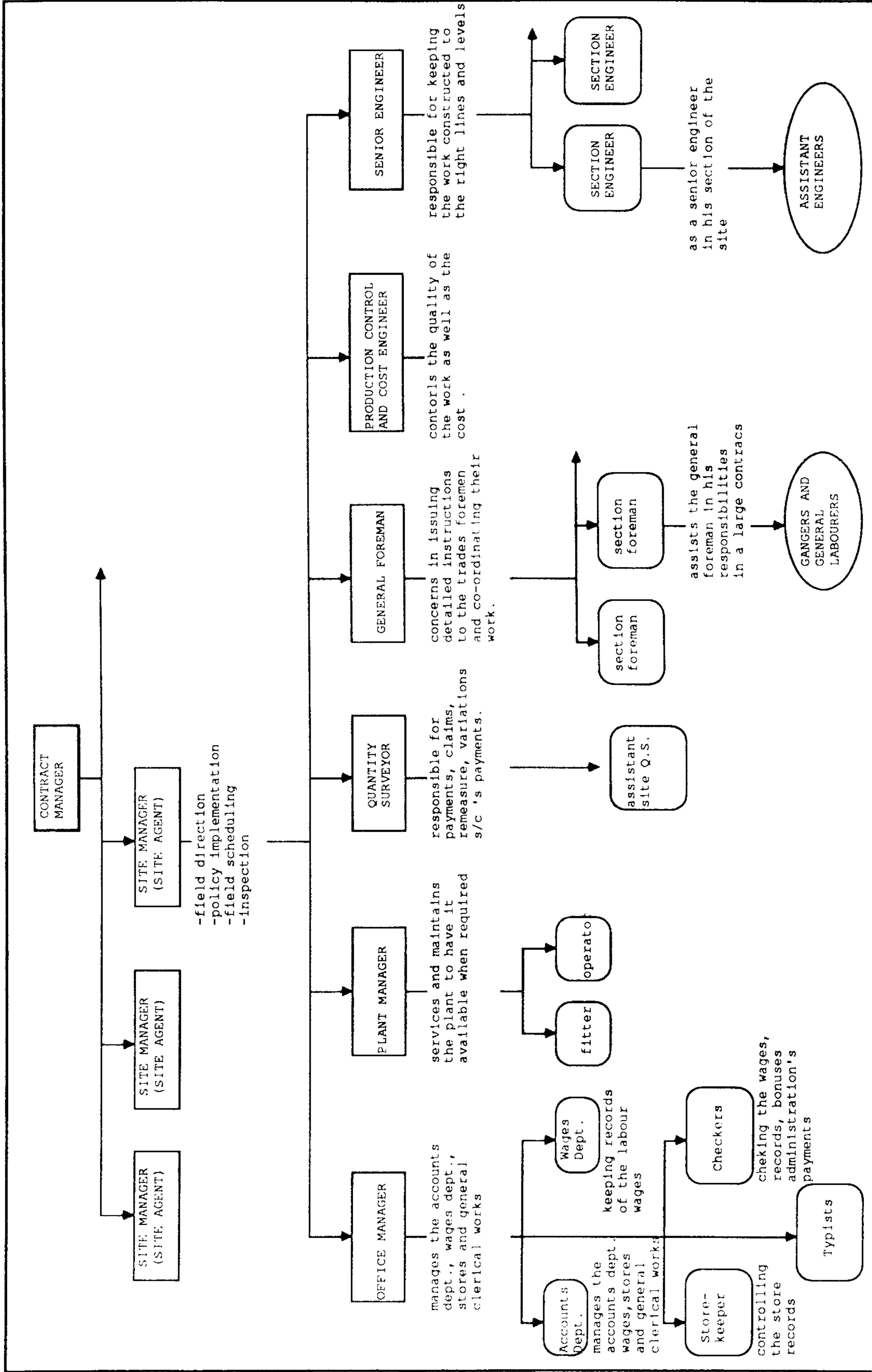


FIGURE (11.2) : THE ON-SITE CONSTRUCTION PERSONNEL WITH THEIR DUTIES

identified. The reports required by the key personnel of the construction organization on and off the site are shown in figures (11.3 and 11.4) respectively.

11.5) USING "PLUS COST" FOR PRODUCING SITE MANAGEMENT REPORTS ON/OFF SITE

From the survey of the available site management software (as explained in chapter three), in which a question has been asked about the output reports provided by the system, the answers showed that the reports produced by the different systems are varied. None of these systems could provide all the control reports required by the construction companies (according to another survey in chapter two).

Before developing the reporting system in PLUS COST, the following reviews have been considered:

- 1 - the construction company's requirements;
- 2 - the construction personnel (on and off the site) duties;
- 3 - the construction personnel (on and off the site) demands from the controlling reports and the type of their presentation;
- 4 - the methods of reporting in use;
- 5 - the required characteristics in the efficient financial reports.

In developing the facility of providing site management reports in

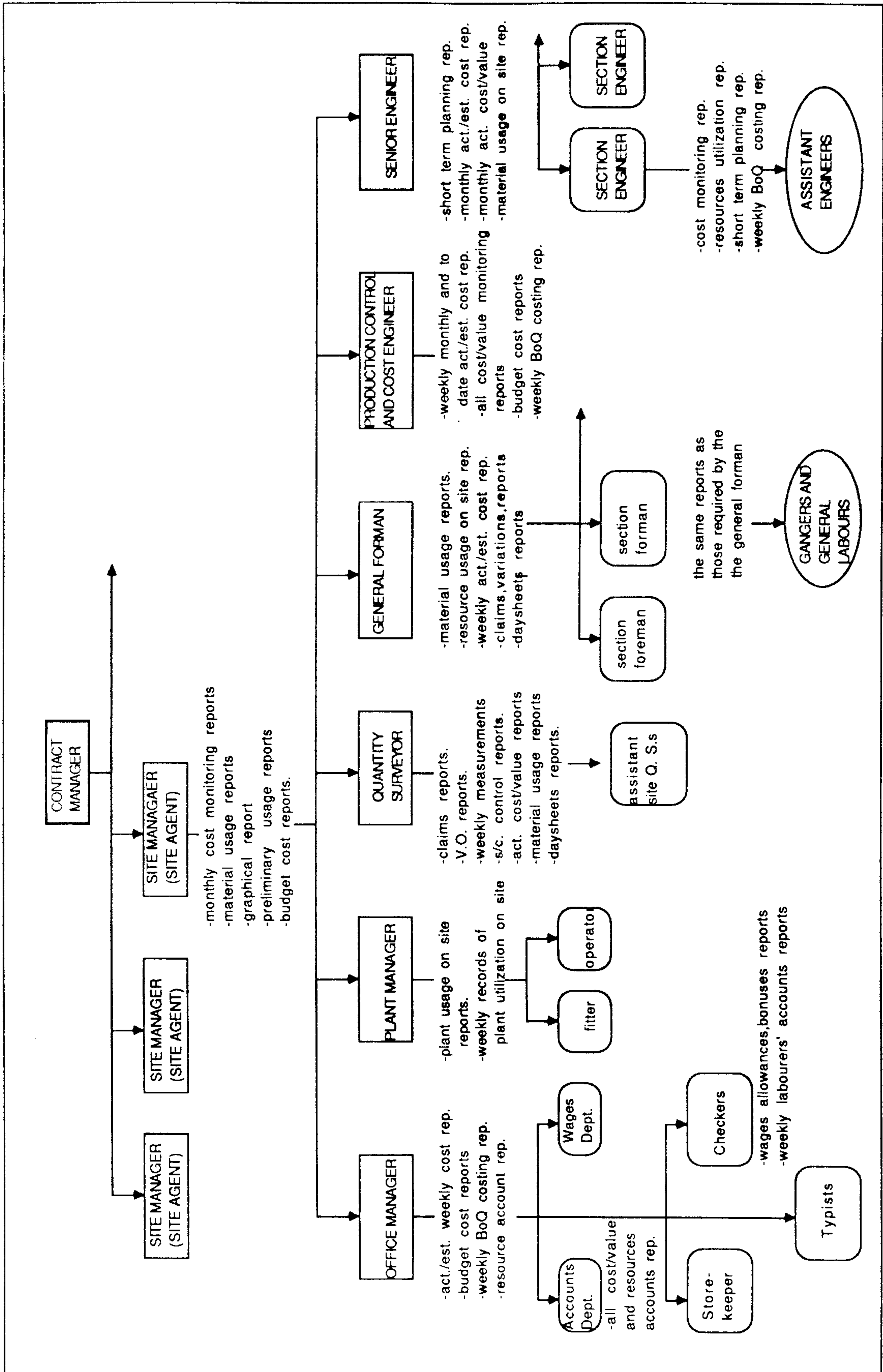


FIGURE (11.3); THE ON-SITE ORGANIZATION WITH THEIR REQUIREMENTS FOR THE SITE MANAGEMENT REPORTS

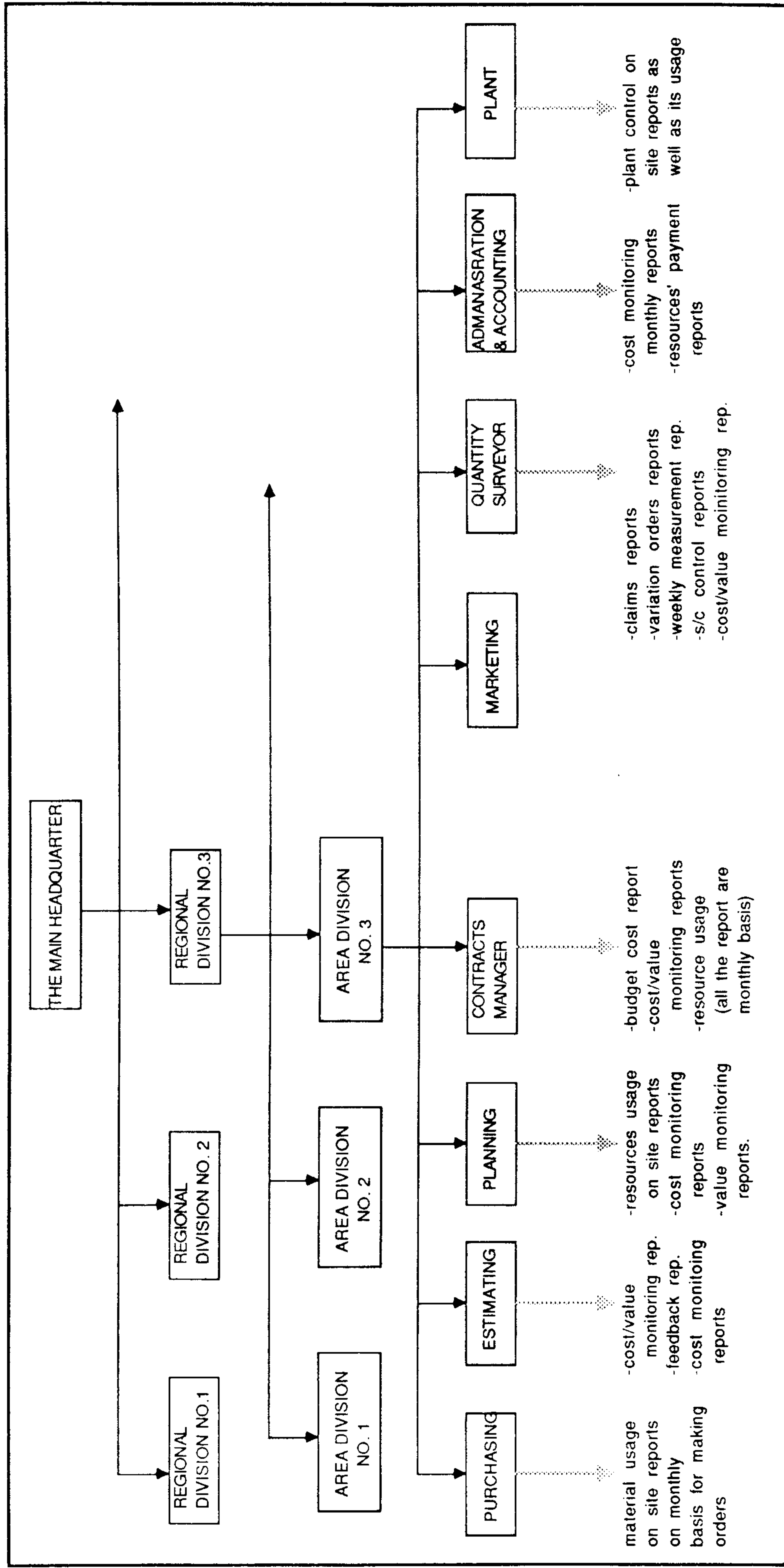


FIGURE (11.4); THE OFF-SITE CONSTRUCTION COMPANY ORGNIZATION WITH THEIR REQUIREMENTS FOR THE MONITORING REPORTS IN THE MAIN OFFICE

PLUS COST, I have depended on the reviews of the first and the second part of this chapter and on the construction company's interviews (as explained in chapter two). Through this facility, I have identified the required characteristics of an efficient site management report. The construction personnel demands (on/off the site) of site management reports has also been established. These demands and requirements have then been used to develop the reporting system in PLUS COST to produce the required reports. The number of the site control and feedback reports are to cover the construction personnel demands, while the presentation of these reports depends on the required characteristics of an efficient site management report, through which the financial figures can be easily and quickly indicated. This has made PLUS COST the first system, so far, that has such an efficient and integrated reporting system which can provide the most comprehensive presentation of the site control data for every construction personnel (on and off the site). Also through this facility, "PLUS COST" has saved a lot of paper work, effort, and time (on and off site) compared with the manual system. Not just that, but the system has provided more accurate control figures within a short time.

Each of the eighteen reports (which are produced by the system) are deliberately produced by the reporting system to provide the control data to one or more of the construction personnel according to their duties in controlling the project. Missing any of these reports will reduce the efficiency of the site controlling

operation in the company management system by making the system lose its integration in providing the site control data to the management personnel. The description of each of these reports and their necessity for construction management are explained in the following.

If the reports are required from the system, the "Preparing Report" option must be selected which offers a list of ten different report's options:

- i) Cost Monitoring Reports;
- ii) Value Monitoring Reports;
- iii) Cost-Value Monitoring Reports;
- iv) Budget Costing Reports;
- v) Weekly Costing Reports;
- vi) Graphical Reports;
- vii) Short Term Planning Reports;
- viii) Material Usage Reports;
- ix) Preliminary Overall Project Reports;
- x) Feedback Estimator Reports;

The following is a description of each option and its reports with the necessity of these reports to the construction personnel on and off site.

The actual cost figures of the work done in the reports are supposed to be calculated from the actual site cost of their resources (labour, plant, material, subcontractor and

preliminaries), which are used to execute the work in that period of time (as explained in chapters six, seven, eight and nine). So that the actual cost will be shown in the reports according to its above resources' figures.

i) Cost Monitoring Reports

"PLUS COST" can provide through this option monitoring reports on the cost of the work executed. These reports can be; weekly, monthly or to-date.

These reports will give a comparison between the actual cost of the work done against the estimates for each cost center. The cost figures will be shown according to their breakdown figures (labour, plant, material, subcontractors and preliminaries).

The reports can be used by different key personnel (on/off site) for control purposes. The weekly reports can be used by General Foreman and the Site Engineer to keep them informed of the financial progress of the project. The monthly reports can be used by the Costing Engineer, Senior Engineer, Accounting Department, Office Manager, Section Engineer and the Site Quantity Surveyor, each according to his interest in using the reports for his control purposes. Also it is useful to the Site Agent for comparing the actual costs with the interim valuation which is supposed to be in monthly periods. To-date reports give the site personnel the ability to obtain monitoring reports whenever required by the upper level on/off site. Also by

comparing the figures in these reports with those in the weekly or monthly reports, the problems of any uneconomic indications can be identified and the week in which the project started losing money.

ii) Value Monitoring Reports

"PLUS COST" provides through this option monitoring reports on the actual value at weekly or monthly periods of time. These reports show the actual value of the work executed as measured by the Site Quantity Surveyor compared against the estimates as allowed by the Estimator, with any extra payments from variations, claims (accepted or expected) and price fluctuation. These comparisons can then be used to relate any differences in the estimated values to their reasons (e.g. performance of labour, usage of material, rise in prices, claims, etc.).

This type of monitoring reports are usually used by the Engineer and Senior Engineer to compare their plans with the actual. They are also used by the Quantity Surveyor on site either to ensure that the work that was executed in that period of time is as expected, or to check his records with the registered claims and variation orders.

These reports are also required by the Site Agent to keep him informed that the project is receiving money as planned. Also he needs such reports to check that all the variation orders and

claims are well considered and to keep him ready for any explanation required from his upper levels in the organization about the project's financial progress.

Finally, these reports are also useful for the Estimating Department at the Head Office to keep them informed on how far their estimates are from reality and the reasons behind it (if there are any). For this reason, they usually use monthly reports to be produced at the same time of the interim valuation.

iii) *Cost-Value Monitoring Reports*

The main purpose of this type of report in "PLUS COST" is for site reconciliation of cost/value according to the actual. In these reports, the actual value of the work done during the selected time period (weekly, monthly or to-date) as measured by the Quantity Surveyor is compared against the actual cost of the resources used.

These reports are very useful for each person in the company organization such as; General Foreman, Engineer, Senior Engineer, Site Quantity Surveyor, Office Manager with his departments (Accounts and Wages), Contract Manager and Planning, Marketing and Estimating Departments. All personal have an interest in keeping the costs within the allowances and to take any action to overcome losses on the project. So that if there are any losses identified through these reports, the user can indicate in which cost center and particularly in which

resource. The corrective action will be sent to that area to be taken by the supervisor to prevent the loss of money.

iv) *Budget Costing Reports*

These reports show the cumulative figures of the actual value and cost to-date and then the variances (in pounds and as percentages) compared with the previous month. The reports have been added for the benefit of the Site Agent, so that the level of detail has been set accordingly. These reports can also be used by the Contracts Manager to enable him to look for the salient features of the financial performance and to seek further information where this is thought to be necessary.

v) *Weekly Costing Reports*

This report is designed for the Site Agent to enable him to have a quick idea of the expenses of the work done weekly and to compare this with the work done so far. It is also useful for the Cost Engineer and Production Control Manager (if any) to keep control of the site costs over a very short time period. The level of detail in these reports has been set according to that, by showing both actual figures of the cumulative to date and this week for each cost center. If any details are required, these can be provided by selecting any of the other monitoring reports through the system which give more details about the actual cost than these reports.

vi) Short Term Planning and Control Reports

These reports have been provided in "PLUS COST" to assist the Section Engineer in his short term plans by showing him within the selected period of time, the usage of the resources and the actual cost/value for each cost center with its breakdown figures. The Section Engineer will compare his plan with the figures in these reports. This comparison will assist him to know how well the project in his section has done financially according to the plan. Corrective action may be taken for the next period of the short term plan, or the plan may be corrected according to the previous report.

vii) Material Usage Reports

This option offers two further types of reports on material usage on site:

- a) Material Wastage Reports;
- b) Material Utilization Reports.

a) Material Wastage Reports

This first type of material reports show the wastage of any particular material resource on site compared to what was allowed by the Estimator (as percentage). From this comparison, the Estimator may modify his estimates of the quantity of that resource required for doing the job. These reports are also essential for the Foreman to keep him informed about how well material resources are used by his workmen. It is also useful for the Engineers to assist them in

giving the orders on site for better use of material resources. The Office Manager might ask to have these reports (as he is responsible for storekeeping of the material) if the high wastage is coming from bad storage.

It is also useful for the Senior Engineer, Section Engineer and even Site Agent to check their plans to make sure that the material is used on site as planned.

b) Material Utilization Reports

This second type of material reports show the material resources which have been issued from the store or delivered to the site and how much of the quantity has been used so far comparing with the allowances. Having a large quantity of specific material (especially expensive material), which cost a lot of money on site without being used as expected, means sometimes big losses of money on site with no return. So these reports would assist in controlling the delivery of such material to the site.

The Engineer, Site Agent and Office Manager use these reports to make sure that the utilization of the material resources are as expected, otherwise, they may take action not to let a big quantity of material accumulate on the site, or stop ordering until the quantity on site has been used. Also these actual figures of material utilization would make the estimated utilization allowances be reconsidered in the future.

viii) Preliminary Overall Project Control Reports

The preliminaries are very effective factors and can cause the construction company a large loss of money (as explained in chapter eight), but they are not considered by many systems. However, this option provides reports on the preliminaries which are priced totally in the preliminary bill (the preliminary that are not related to any cost center and usually estimated as additional costs over the contracts amount by a separate budget "Preliminary Budget PB").

The Head Office Departments may keep the Site Agents and the Office Managers (Accounts Departments) informed about the allowed expenses of each preliminary such as: fuel, oil, etc., with a specific period of time, so that Site Agent and his staff on site can control their expenses within these limits. They check (on weekly or monthly bases) their expenses on preliminaries and where they were expended, and then compare them with the previous period from the to-date reports.

These reports can also be used by the Estimator as feedback reports on his Preliminary Budget (PB).

ix) Graphical Reports

All the previous reports have been developed in "PLUS COST" by using the "Conventional Financial Method" of reporting. This option provides reports of another type which is; "Graphical Method" of reporting. This method of reporting in

"PLUS COST" provides reports in graphs. These reports are used in case there is no time to look through all the figures to indicate the progress of the work. The reports will give quite clear and quick indications of the project progress financially, just by looking at the graphs (the estimated against the actual) in the reports.

This option offers two types of control graphical reports which are:

- To-date Actual/Estimated Cost Reports;
- To-date Actual Value/Cost Reports;

These reports can be used with the previous control reports as subsidiary reports to give a clear and detailed indication of the financial progress of the project.

x) *Feedback Reports*

These reports are specially designed in "PLUS COST" to assist the Estimator in updating his Estimates for any future work. The reports will show, for any selected cost center, the quantity used and the budgeted costs of the resources used to execute the work in that selected valuation. These figures will be shown for all the items involved in that work through the selected cost center. The figures are then compared against the incurred costs on site (as actual figures). The variances will be shown at the end of the reports. Through these reports as well as the previous ones, all the estimator's

figures will be sent back to him with the actual (incurred on site) figures, so that he can amend or update his estimates for any future estimate.

All the reports provided by the "Report Preparing" function can be used as feedback reports with or without the comments of the site personnel who were in charge of executing the work on site (as explained in chapter ten).

As I mentioned before, these eighteen print-out reports as well as those on-screen reports which are developed to be provided in different periods of time, methods of reporting and ways of presentation has made the reporting system in "PLUS COST" quite effective in providing the control and feedback reports on site by making the best use of the site data. It has also made PLUS COST achieve the required integration in the construction management data, on and off the site, by the construction industry.

All the above reports provided by the "Preparing Reports" function are shown in detail in Appendix S, figures (1-18).

11.6) SUMMARY AND CONCLUSION

The following points are the summary of the work done within this chapter and a conclusion from it:

- 1) In any site management system, the reporting system must receive a great deal of consideration. The

efficiency of the site management system depends on the efficiency of its reports in describing and indicating the financial information clearly and effectively.

- 2) From the survey of the available site management software (as explained in chapter three), in which a question has been asked about the output reports provided by the system, the answers showed that the reports produced by the different systems are varied. None of these systems could provide all the control reports required by the construction companies (according to another survey in chapter two).
- 3) Before developing the reporting system in "PLUS COST", the following reviews have been considered:
 - a) the construction company's requirements;
 - b) the construction personnel (on/off the site) duties;
 - c) the construction personnel (on/off the site) demands form the control reports and the type of their presentation;
 - d) the methods of reporting in use;
 - e) the required characteristics in the efficient financial reports.
- 4) After the points above have been considered, "PLUS COST" was then developed to have the most efficient, comprehensive and integrated reporting system so far. The reporting system was developed to provide reports concerning all the five points above. The reports provide

the site control data to every construction personnel (on/off the site) through their different presentation and the data included in each report to achieve the demands of those personnel.

- 5) "Preparation Reports" function in PLUS COST can provide up to eighteen print out control and feedback reports, by using different periods of time, methods of reporting and ways of presentation. These reports are expected to cover all the construction management demands from the site management reporting system.
- 6) Those eighteen output reports have proved (according to the model evaluation in chapter twelve), that for the first time that the computer-aided system has achieved the objective of having an integrated and efficient reporting system as part of a site management system.

At the end of this chapter, I have fulfilled the objective of having an integrated site management system. In which "PLUS COST" has been developed to have a reporting system that can provide up to eighteen different site management reports. In addition to that, there are twelve on-screen reports provided through the system options. The reporting system can also provide the reports in figures or in graphs. All these above features in the reporting system have made "PLUS COST" achieve the requirements of having an integrated computer-aided an efficient site management reporting system.

CHAPTER TWELVE

CHAPTER TWELVE

MODEL EVALUATION AND RESEARCH CONCLUSION AND RECOMMENDATION

12.1) INTRODUCTION

The construction Industry suffers from not having an integrated site management software system which can achieve efficient site management requirements and provide better use of site control data. Despite the length of time that computer-aided systems have been used for construction management functions such as; Estimating, Planning, Valuation, etc., there is no indication of any efficient and integrated site management software being developed which could achieve the "Business Requirement" specification of the construction industry (described in chapter three)

Through this research, the above problems have been traced. Three surveys were undertaken on; literature, construction companies and available software. From the surveys, I have identified;

- the needs from literature;
- the needs of construction industry;
- the facilities of site management already available;
- the requirements from the computer-aided system to meet all the above needs.

From the above four set of findings, I have reached, for the first

time, to a list of specification (Business Requirements specification) to be used as basis for developing an efficient and integrated site management system. "PLUS COST" has then been developed as the first serious attempt of providing an integrated site management system which can achieve these specification. "PLUS COST" has been developed to fulfill, as never before, the promises of having:

- data integration between the management systems;
- data feedback through the integrated system;
- reduction in the effort of time, staff and data collection from the site;
- output formats patterned for different site management users demands;
- a system which is simple, interactive, efficient in capturing the data from the site sheets.

Chapters one to eleven explained, in detail, the above site management problems, the manual methods used in managing the site and how "PLUS COST", as the first serious attempt, can assist in solving each of these problems by using new and more efficient methods of site control and management as never used before.

This chapter contains the evaluation of the model "PLUS COST" as a whole from the point of view of industrialists who attended a demonstration (in slides and on-computer) and completed a questionnaire on the model. The chapter also contains the research conclusion from this evaluation and the other chapters. Finally, the chapter lists the recommendations for further research.

By the end of this chapter, I will have finished my research in which I have analyzed the site control problems, identified the site requirements of an integrated efficient computer-aided site management system and provided a solution achieve by developing a computer-aided site management system (PLUS COST). The use of this system in construction management will be a remarkable step forward in the use of computer-aided systems. Its use will provide a more integrated construction management and make better use of site control data.

12.2) MODEL TESTING AND EVALUATION

12.2.1) Case Studies

"PLUS COST" has been developed to assist in achieving the "Business Requirements" specification of an integrated site management system and make better use of the site control data by providing a feedback facility to upper management on site, as well as to Main Office Departments. The next stage is to test and evaluate the system in achieving the above requirements and functions. A number of case studies have been undertaken on the system as demonstrations (in slides and on-computer seminars) to construction industrial personnel who are in charge of site management in their companies. In the demonstration, I have undertaken firstly on-slides seminars which explained the system structure, facilities, functions, operating features and its reports (both on-screen and print-out reports).

Secondly, the on-computer seminars by running the software and showing the system in detail on the computer screen.

Following the demonstrations, an evaluation questionnaire was given to the participants to enable them to give their comments on the system. I have used some of these comments to modify the system's structure and its control reports, while the rest of the comments were used as conclusions and recommendations for future research in the same field.

In selecting industrial people as case studies on the model I have considered; different sizes of construction companies, the number of years site experience (a minimum of ten years) and then the management position. Six different cases have been carefully selected to cover both types of construction work (Building or Civil Engineering), on which to use the questionnaire has been used for evaluating the system and identifying recommendations on the research as explained later in the chapter.

12.2.2) Model Evaluation

The six questionnaires collected from the case studies (as mentioned before) are presented in tabular format figure (12.1). In the table, I have listed the facilities of "PLUS COST" in managing the construction site (as listed in the questionnaire). The answers of the industrial personnel on these facilities and their confidence in the feasibility of applying each of these facilities on the site by the system have been listed underneath. From the evaluation table, the following points have

CASE STUDY (COMPANY NAME)	DATA ACCESSING				BONUSING INDICES			LABOUR CONTROL			
	Understanding	providing from data file	typing into the system	Comments	Application of The System	Sufficiency of View rep.	Comments	Data Entry	Effectiveness of the system	Sufficiency of the System	Comments
WILLIAM DAVIS	Easily	Enough	Easily	None	One of them is in use	Enough	None	Easily	Good	Enough	None
WILLIMOTT DIVON DESIGN AND BUILD LTD.	Easily	Different System	Easily	None	One of them is in use	Enough	None	Easily	Very good	Enough	None
SHEPHERD CONSTRUCTION LTD.	Easily	Enough	Easily	None	One of them is in use	Enough	None	Easily	Very good	Enough	There is only Labour-in- Group System
KIER MARRIOTT	Easily	Enough	Easily	None	One of them is in use	Enough	None	Easily	Very good	Enough	None
BALFOUR BEATTY	Easily	Enough	Fair	None	One of them is in use	Enough	None	Easily	Good	Enough	None
GAMMON INDIA LIMITED	Easily	Enough	Easily	None	One of them is in use	Enough	None	Easily	Good	Enough	None

FIGURE (12.1) ; THE "PLUS COST" EVALUATION TABLE

SYSTEM GENERAL FEATURES										THE ATTENDANT'S MANAGEMENT POSITION	YEARS OF EXPERIENCE
Simply Understood	Saving time in getting Rep	Data entry from the Site Sheets	Saving in the Staff required for collec. Data	Integration of the system	Solving the site problems	Efficiency in cont. the site	General Comments				
Yes	Yes	Easily	Yes	Not sure	Most of them	Very good	None	Cost Eeapartment Manager	18		
Yes	Yes	Easily	Need to be seen working on the site	Yes	Most of them	Very good	None	Managing Director	10		
Yes	Yes	Easily	Not sure	Yes	Most of them	Required to be working on site	availability of weekly measur. done on monthly basis only	Chief Production Controller	20		
Yes	Yes	Easily	Yes (if the cost of the system not that high)	Yes	Most of them	Very good	None	Chief Cost and Bonus Surveyor	26		
Yes	Not sure	Easily	Not sure	Yes	Most of them	Very good	as it is general, it is required modifc. to suit any specif. contract	Contracts Manager	23		
Yes	Yes	Easily	Yes	Yes	Most of them	Very good	it is required to be tested on site before deciding on the system accurately	Managing Director	25		

FIGURE (12.1_ CONTINUED)

PLANT CONTROL		SUB-CONTRACTORS			MATERIAL CONTROL			PRELIMINARY CONTROL				
Data Entry	Sufficiency of the used data	Sufficiency of the used rep.	Comments	Covering of Comp. Requir.	Sufficiency of View Rep.	Comments	Achieving the Comp. Req.	Sufficiency of View Rep.	Comments	Data Entry	Coverage of The Com. Req.	Sufficiency of View Rep.
Easily	Enough	Enough	None	Most of them	Enough	None	Most of Them	Fair	add. thoughts to be given to the prob. of late invoicing	—	—	—
Easily	Enough	Enough	None	Completely	Enough	None	Completely	Very good	None	Easy	Completely	Very Good
Easily	Enough	Enough	None	Most of them	Fair	More involved in Labour-only Sub-Cont.	Completely	Very good	None	Easy	Completely	Very Good
Easily	Enough	Enough	None	Completely	Enough	None	Completely	Very good	None	Fair	Completely	Fair
Easily	Enough	Enough	None	Completely	Enough	None	Completely	Fair	Slightly diff. than what is used at the Comp.	Easy	Completely	Good
Easily	Enough	Enough	None	Completely	Enough	None	Most of Them	Very good	None	Easy	Completely	Good

FIGURE (12.1 _ CONTINUED)

been identified:

1 - On a question about the integration facility in the system, through which "PLUS COST" can accept the required management data either manually or accessed from the data files of the other systems, all the cases showed that the manual method:

a) is easy to understand;

b) is easily obtained from the company data files;

c) is easily typed into the system by the user.

2 - All agreed that at least one of the Bonusing systems used in the "Bonusing" facility is used in their company. The on-screen reports are sufficient in providing the required data.

3 - The answers to the questions about the "Labour Control" facility, all showed that:

a) the data entry is easy to understand;

b) it is easily provided from the site sheets;

c) the view reports are sufficient in providing the required control data.

4 - All the answers to the questions about the "Plant Control" facility showed that:

a) the data required for the system can be easily provided from the site sheets;

b) the data required is sufficient to control their plant;

c) the view reports are sufficient in providing the required control data on the site.

5 - About the "Sub-Contractor Control" facility the answers on this facility were as follows:

- a) all but one answered that the facility is covering all the company requirements for controlling the subcontractor;
- b) all except one answered that the view reports are sufficient for controlling the subcontractor's work;
- c) only one asked for more details about Labour-only Subcontractors as he is more involved in that field.

6 - The answers on the questions about the "Material Control" facility were as follows:

- a) two companies answered that the facility achieved most of their requirements for material control on site. The other four cases agreed that the facility achieved the requirements completely;
- b) two cases said that the facility provides fairly sufficient data through its view reports;
- c) the comments on the facility were; one of them asked for further thought to be given to the problem of late invoicing by suppliers.

The other comment was they need some modifications on the system to suit their own system.

7 - All the cases have agreed on the following answers to

the questions about the "Preliminary Control" facility in the system. The answers were:

- a) it has easy data entry by using the site sheets;
- b) the facility covers all the requirements of the preliminary control on site;
- c) the view reports of the facility covers the required control reports from the facility.

8 - The answers to the questions on the "On-Cost Overheads", all agreed that:

- a) the facility is necessary to be involved in the site management system;
- b) it is being used by the cases companies;
- c) the facility achieved the requirements of companies from it.

9 - The facility "Claims Registration and Measurements" in the system has the following answers, agreed by all the cases:

- a) it solves the claim problems on site;
- b) it is quite efficient in dealing with the claims on their site;
- c) the facility covers all the required reports to control claims on site.

10-The answers on the facility of "Variation Orders and Daywork Valuation" have also agreed on the following:

- a) the system deals with the above valuation efficiently;
- b) the view reports are sufficient for

the requirements of their companies.

11-The cases were also asked through the questionnaire to give their comments about the "Print-Out Reports" of the system. The answers were:

- a) the reports are quite sufficient in controlling the site and providing the required controlling data to the Main Office;
- b) the presentation of the reports is easily understood;
- c) the reports have achieved a good coverage of the company's requirements.

12-On the question about the "Feedback" facility, the answers were as follows:

- a) it is very necessary to have this facility in the site management system to help the estimator to update his estimates;
- b) the facility in the system is quite efficient in achieving the feedback of site control data back to the upper levels on site and Main Office Departments;
- c) there was only one comment which required the system to be field tested before they can say much about this facility in the system.

13-The rest of the answers which were about the system's general features were as follows:

- a) all agreed that the system is easily understood;

- b) all but one answered that the system will save time in obtaining reports;
- c) all the answers identified that it is easy to enter the data from the site sheets by using the system;
- d) three answers said 'Yes' to the question on saving in the staff required. One asked to see the system working on site and the other two were not sure about the answer;
- e) all the cases have agreed using the system saves in the time required for collecting the data from the site;
- f) all but one agreed that the system is more integrated than the system which is currently in use in their companies;
- g) all the cases agreed that the system solved most of their site management problems;
- h) about the efficiency of the system, all agreed that they expect the system to be quite efficient in controlling the site;
- i) the general comments were that the system needs slight modifications to serve the specified conditions of the companies by testing it on site and modifying it accordingly.

14-The overall comments on the systems were very favorable as the personnel were very impressed with the system and they thought it is better than anything on the

market at the moment as it is a comprehensive and detailed site management software. Using such a system, they expect, will improve the construction management and make it more integrated and efficient compared with the systems, they currently use.

From the above evaluation as well as the conclusions of the previous chapters the final conclusion and the recommendation of the research for any further work in this field (as explained later in this chapter) has been identified.

12.3) RESEARCH CONCLUSION

From the work done in this study and as a result of the case studies on the integrated computer-aided site management system "PLUS COST", the following have been identified as the overall conclusion of the research:

- _ The site management is a process whereby the management ensures that the construction company as a whole achieves desired standards of costs and values established at the estimating and planning stages, by using actions directed towards achieving these standards.
- _ Construction company site management still suffers from difficulties such as a:
 - a) large number of staff required for data collection and calculation on site;
 - b) long time spent for producing the control

reports;

c) deficiency in the site control reports;

d) deficiency in the use of the site data for the project management.

— The research back ground has shown that there are still number of technical constraints impeding the computing of the construction management data. These constraints lie in the management systems and data structure;

— Three surveys have been undertaken to identify these constraints. The surveys were undertaken to investigate:

a) the existing knowledge in the literature on the aspect of site management and its integration requirements;

b) the integration level of the current site management systems used by the construction companies;

c) the construction company requirements of an efficient and integrated management system;

d) the achievement level of the available site management software;

These surveys indicated clearly and for the first time the absence of an effective integrated site management system. Broadly speaking, the software available are still unintegrated, self-contained and mainly designed for accounting purposes.

— The surveys identified the existing constraints (which

have stopped the current integration in the management information systems). These constraints appeared as gaps between the management information systems which impeded the free flow of the management data down to the construction site, thus enabling feedback from the site with its control results to the other managerial data bases;

— The surveys also stated that the major constraints were in:

- * the management systems; as there was no integration in the management systems, the management data could not be accessed between the systems, to enable feedback of the data with its control results;
- * the data systems; as there was no standardization in the data input and output in the management systems. It was not feasible to access the data between the systems.

— The surveys also stated some other minor constraints such as;

- * no standardization in the computing languages used in the different systems;
- * no standardization in the data filing and retrieval between the different systems;
- * traditional practices of the software houses in their attempts to develop computer-aided management systems, took no account of the integrated relationship between the management functions.

— According to the above surveys and their findings,

the research objectives were established. Through these objectives, I have achieved the promise of providing an integrated and efficient site management which makes better use of the management data by developing an integrated computer-aided site management system named "PLUS COST" (site management PLUS COSTing). The model software lodged with Loughborough University of Technology, Civil Engineering Department.

— Chapter three has achieved the first objective of "examining the adequacy of the available software compared to the requirements of construction companies". The Business Requirements specification of an integrated computer-aided site management system have been identified, for the first time, as a conclusion of the chapter and a result of this comparison. The specification indicates clearly, as never before, the basis for developing or improving any site management system to meet the construction industry requirements. This specification has then been considered in developing my system "PLUS COST".

— Through chapter five, I have reached the second objective which was "examine the feasibility of having an integrated site management system by accepting data accessed from the data files of other management systems of; Estimating, Planning, Cashflow Forecasting and Valuation and Measurement". Having achieved this integration, PLUS COST is expected to be the only system

at the moment which has bridged the gaps of accessing the management data between the different management systems down to the construction site, where, the management data will be used for efficient site management. So that this chapter has achieved the first part of the research hypothesis.

— From chapter six, the required site control (cost and performance) of Labour Resources (as one of the secondary objectives) has been achieved efficiently by using the same data as in the site sheets that are already in use by the manual systems. It has been developed to be applicable to both types of labour cost control systems (Timekeeper and Ledger) for both types of contracts (Building and Civil Engineering). It has also considered all of the other on-site labour costs, such as; Bonuses and On-Cost Labour Overheads. All the above facilities of "Labour Control" have made PLUS COST the only system, amongst the available software, that has fulfilled the promise of providing an efficient "Labour Control" system.

— Also through chapter six, and for the first time, PLUS COST (as a computer-aided Plant Control system) has fully considered all the difficulties of allocating and controlling plant resource cost and performance. It has been developed to meet all these factors by having six points to be considered before using the facility, as well as making the data entry general for all the plant expected costs on site. PLUS COST is also expected to be

a unique system in providing a set of on-screen reports on plant cost and utilization (performance) to reach the required efficiency in plant control on site as never achieved before by the available software.

— Through the last part of chapter six, another secondary objective has been achieved, in which I have reached, for the first time in the available software, a very advanced stage in the "Material Control" on site. through this objective "PLUS COST" has fulfilled a full coverage of material usage on site by letting all the related data about suppliers, orders, deliveries, material fixed and unfixed on site to be entered. This data will be used to produce a complete set of control reports (both on-screen and print out) to cover all the management demands of controlling the material usage, utilization and wastage on site.

— There are considerable difficulties facing the Main Contractor in combining the efforts of a group of Subcontractors. These difficulties are often increased by a lack of detailed knowledge of Subcontractor operations and even in many cases by an insufficient systematic approach to subcontract management. In chapter seven , I have identified the above difficulties and considered them in developing PLUS COST to control Subcontractor on site. It has been developed to accept both types of Subcontractor Control (Short and Medium Term). It has also been developed to provide data about the Subcontractor's Letting Margins, Liabilities and

Monthly Accounts, to meet the whole demands of the Contractors for controlling their Subcontractors. PLUS COST can also provide data about the Subcontractor's claims and variation orders separate from the Main Contractor's. These above features of Subcontractor Control function have made PLUS COST the most efficient system (amongst the available software) used on site for controlling the Subcontractor cost and performance.

- _ Despite the influence of the preliminaries on the accuracy of the financial control of a contract, none of the available software has considered the preliminaries in its control functions. This is one of the reasons the available software is still behind in fulfilling the promise of providing an efficient site management system. Through chapter eight, I have developed "PLUS COST" as the first system, between the available software, to consider the Preliminary Control on site. "PLUS COST" uses two types of controlling methods for preliminaries on site depending on whether the preliminary is Bill Item or part of the Item Rate, in order to cover all the preliminaries incurred on site and to get like-to-like control figures in the comparison reports. The entered data will be used in providing reports (both on-screen and print out) on overall projects and in-rates preliminary control. These reports will achieve the required preliminary feedback data to the Estimator for the purpose of having an efficient financial reporting

values. In the first part of chapter nine and from the review of the literature about the claims I concluded the efficiency requirements of Claim Control on site. These requirements are then used to develop the Claim Control function in PLUS COST. Using this function will provide firstly, the facility of measuring and evaluating all the resources used in these claims which will be added automatically to the actual value at the time of valuation to produce the control reports. Having these two facilities of claims in "PLUS COST" has made the system more efficient than the other available software and its control figures more accurate than any other software available at the moment.

- Variation order is another practice which influences the contract amount, because of the addition or omission of the contract item rates or quantities as a result of changing or replacing of drawings or the methods of executing the contract. The second part of chapter nine reviewed this practice and its problems of registration and measurement on site to achieve practically and accurately more efficient site control procedures. The review was then used to identify the implementation of the variation orders in PLUS COST (as the first site management system so far, to consider the variation orders in controlling the construction site). This function in PLUS COST is able to keep a record of all the variation orders and their measurements. The actual values in the control reports will be adjusted

system.

- _ Through these resource control functions (Labour, Plant, Material, Subcontractor and Preliminary), PLUS COST can achieve both the project control on site as a whole, as well as its resources usage and performance. This has made the control procedures more effective than before in indicating the inefficient working area down to the fourth level of site organization (foreman level).
- _ In addition to the project site cost/value, in chapter nine, I have identified that there are several site practices which might occur on site influencing the accurate control figures of these costs/values. Each of these practices, such as; Claims, Variation Orders, Daywork and Price Fluctuation has its way of influence on the actual site figures which could then change the final contract amount. None of the available software has considered these practices. That has made these software still inefficient in their control operations because of the inaccurate site control figures. In chapter nine, I have considered these practices and their importance and influence on the efficiency of the site control procedures by developing PLUS COST to be a unique system, amongst the other software, which considers these practices as functions within the system.
- _ Claims as one of the above site practices requires a lot of attention. A big effort in time and staff may be required to control claims on site and assess their

automatically according to these measurements to produce dead accurate control figures. The function also provides a set of on-screen reports for controlling these orders and their measurements on site.

— Through chapter nine, I have also identified that Daywork is also another practice which might occur on the site and influence the actual figures of the work. I have developed PLUS COST to consider this practice as one of the adjustment figures of the actual calculated value in the control reports. None of the available software has this facility and that has made their control figures inaccurate, and control of the site by using these systems inefficient. All the dayworks and their measurements can be entered through this function in PLUS COST to be used then automatically within the system for adjusting the actual values before producing the control reports.

— The last part of chapter nine reviewed Price Fluctuation as the last site practice, on which PLUS COST has been developed to adjust its actual value before being used in producing the control reports. None of the available software (site management systems) has considered price fluctuation in calculating or adjusting its control figures, and that has made these software less efficient and accurate in controlling the construction site. "PLUS COST" is considered the first and the only site management, at the moment, that has implemented this practice in its site control operations. All the

calculations for the monthly price fluctuations figures will be achieved within the system. The figures will then be added to the actual value figures before being used in the control reports. This function can be used for both Civil Engineering and Building work by using the suitable Price Adjustment Formula for each type of work.

— The above four site practices (claims, variation orders, daywork and price fluctuation) could be available by a valuation system (e.g. PLUS VAL). In this case, the actual value figures that are accessed from this system's files will be already adjusted, and there will be no need to use these functions (or this function) again in PLUS COST. Otherwise, PLUS COST will do all the required adjustments on the actual values which are accessed from the valuation system if they were not adjusted. This type of control in the management data between the different management system has not been reached before in any of the available software in the market at the moment.

— One of the main purposes of any site control system is to provide the relevant feedback, carefully qualified in detail by all the conditions under which the work has been executed to the personnel. The corrective actions may then be ordered on the site to overcome any uneconomic indication that may appear. The research has identified that the feedback either doesn't exist in the available software, or it is available just to the Estimator as a list of historical figures. Chapter ten

identified that the lack of the data integration between the management systems is the reason behind inefficient feedback. Before developing this function in PLUS COST, chapter ten reviewed this aspect and identified its necessity to all key personnel on and off site. PLUS COST was then developed to achieve this function by using an efficient technique not previously available.

— Data feedback function has been developed in PLUS COST by considering the necessity of this aspect and the data required to all key personnel on and off site (described in chapter ten). The feedback reports required have been indicated according to that necessity. PLUS COST has then been developed to achieve the feedback function efficiently by accessing the estimates (cost/value) and the actual values from the other departments (as being integrated to their systems). This data will be compared against the actual cost (calculated by PLUS COST) and presented in feedback reports with the comments of the site personnel in charge. The reports will be sent back to the upper personnel/departments (from which the estimates are accessed). The uneconomic operations can be easily and quickly indicated with the comments of the reasons behind that from the people in charge.

— PLUS COST has achieved the second part of the research hypothesis of free flow of the management data as feedback to the other management data basis by; firstly achieving the required data integration in the construction management systems and bridging (closing)

the integration gaps that existed in the previous software. Secondly, considering the necessity of the feedback for each personnel/department, the data requirements of them from the site and the types of the reports required. The above considerations have made PLUS COST and its feedback facility the most integrated and efficient existing feedback function between the available software.

- The efficiency of the site management system depends on the efficiency of its reporting system in describing and indicating the financial information clearly and effectively. From the research survey on the available software, I have identified that none of the systems could provide all the control reports required by the construction companies. A set of reviews have been undertaken through chapter eleven before this facility has been developed in PLUS COST. The reporting system in PLUS COST has been developed to provide reports concerning: the companies requirements from an efficient reporting system, the project personnel site control duties and demands from the control reports and the required characteristics in the efficient financial reports. The eighteen output reports have proved, according to the model evaluation, that it is for the first time, this reporting system is the most integrated and efficient system that has been developed so far.
- From the case studies which were undertaken on PLUS COST through this chapter, I have identified the

following construction points:

- a) the system is preferred, because it is simple, easy to operate and the required management data can be provided from the company's data files;
- b) despite the specific demands from the system, it can achieve most of the construction industry site control demands, both Civil Engineering and Building, and that has made the system quite sufficient in achieving the site management requirements;
- c) there is a growing demand for computer-aided systems like PLUS COST, which has been developed from compiling the actual problems in the construction industry with the literature and the computing skill in solving the problems;
- d) the other important points to be considered in developing an efficient site management system is that the system must save time, money and staff required on site. I have concluded that some companies judge on the system (whether or not they are going to use it) depending on how much the system will save in the staff and the time required in comparison to their own systems;
- e) because PLUS COST has been developed on

the FIDIC conditions of contract (International Contract Conditions), as well as ICE and JCT conditions, it is feasible for PLUS COST to be applied for managing the construction site of any international contract.

— Because so many different site conditions and different controlling and measurement methods are in use by the construction companies, it is desirable to use the structural programming principles, so that:

a) it is more convenient to modify a sub-system instead of the whole system (i.e. the required modification would be less). PLUS COST has been developed as sub-systems, each sub-system achieves one of the facilities in the system;

b) also by using the structural programming principles, it would be possible to change sub-programs without interrupting the whole program too much. This makes PLUS COST more developed, flexible and easier for any modifications required.

— Finally, and from the model evaluation case studies, the research has achieved the hypothesis by demonstrating (through PLUS COST) that the integration constraints between both (the management systems and the data systems) can be bridged to let the information flow freely down to the construction site, thereby, providing

efficient site management. The site will then send the data as feedback to the other managerial data bases, thereby, improving them. Such free flow of information will be of great benefit to management at all levels in the construction industry.

12.4) RESEARCH RECOMMENDATIONS

The following are my recommendations for the work done through this study. These recommendations can be considered for any further research in this field. The recommendations are:

- 1 - Any attempt to develop a computer-aided construction management system must start by developing a general software which can then be specified to suit the entire specification of that construction company. Using the structural programming principles in developing the software will assist in achieving the required modifications on the part of the general software, whenever required, without interrupting the whole software too much.
- 2 - The next development step of "PLUS COST" is to be linked to a computer-aided cost forecasting system. This step does not need more than a couple of sub-systems which will predict the cost of each cost center for the coming period of time by comparing the estimates with the actual. This comparison can be used as a percentage to predict the expected actual cost from the estimates for the next period.

- 3 - Using PLUS COST on site required weekly data feeding into the system, so that the system can calculate and provide the weekly control reports. Further research is required to examine the site documentations and data recording systems needed to get the optimum efficiency of such a system on site.
- 4 - PLUS COST (as an integrated site management systems) provides feedback to the Estimator as comparison print-out reports. The Estimator can analyze the reports before updating his estimates in the data files manually. The research suggests that further research can be carried out to examine the feasibility of updating the Estimator's data files direct from the site feedback data files. The other suggestion is to provide separate feedback data files through the estimating systems to be used by the Estimator in updating his estimates.
- 5 - Expert systems techniques can be quite useful if such a system has been developed to predict the solutions of the site control problems. So that "PLUS COST" will produce the controlling reports, the site personnel will type in the reasons behind any uneconomic indications and the expert system will take the reasons and predict the solution for these uneconomic indications by using the previous experience of the construction people.
- 6 - From the other side, PLUS COST can be quite useful to the expert system's techniques (e.g. expert system for plant selection). In this case the selection of plant will depend on many factors, one of them is the cost of the

plant and its performance. After the plant has been selected by using estimated figures of its cost and performance (which are stored in the data files), " PLUS COST" can then send back the actual cost and performance of that plant item to update the data files.

- 7 - To achieve a fully integrated construction management system, it is necessary to centralize the data files and all the construction management systems such as; Estimating, Planning, Cashflow Forecasting, Valuation and Site Management and Control will have the access to these data files to get the required data for their systems. The data in these files will include; the estimated/actual resources cost/value and their performances, the Bill of Quantity Item rates, the quantities executed, and any site documents such as Engineer's/Architect Instructions, Claims, Variation Orders, etc.
- 8 - Finally solving the problems of the site management like solving any real-life problem requires cooperation between the on-site personnel (who are in-charge of the site), the site Engineers (who are responsible for resolving the site problems) and the computer scientists (who are in-charge of using their skill for developing computer-aided systems to assist in solving the problems).

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APPENDICES

APPENDIX (A)

FIGURES (1-9); SHOW THE DATA ENTRY OF "DATA PREPARATION" FUNCTION, AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF THE USER INPUT.

DATA GENERATION PROGRAM
 =====

- Bill Items Data -----1
- BOQ Valuation Data -----2
- Resources Data -----3
- Sub-Contractors Data -----4
- Cost Center Data -----5
- Sections Data -----6
- Unfixed Material Data -----7
- Engineer's Assessment for Price Adjustment ---8
- Exit -----9

Which do you want ? 1

Bill No. ? 2

Bill Page No. ? 1

Item Code ? 212A

Item Description ? REMOVAL OF EXISTING SEWER OR DRAINS 150MM DIA.

Item Unit of Measurement:

- Millimete ----- MM
- Meter ----- M
- Square Metre ----- M2
- Hectar ----- HA
- Kilogramme ----- KG
- Tonne ----- T
- Sum ----- SUM
- Number ----- NR
- Hours ----- HR
- Week ----- WK
- Others .. enter its 3letter abbreviation

Unit of Measurement ? M2

Item Quantity ? 62.9

Item Rate ? 1

Item Rate Breakdown Proportions(I):

- Labour ? 31
- PLANT ? 5.4
- Materials ?
- Subcontractors ?
- Preliminaries ? 5
- Overhead and Profits ? 10

Cost Center/Activity Code No. ? 2

Is it subject to price fluctuation ? -Y/N N

1	Bill No. -----	2	
2	Bill Page No. -----	1	
3	Item Code -----	212A	
4	Item Description -----	REMOVAL OF EXISTING SEWER OR DRAINS 150MM DIA.	
5	Item Unit Rate -----	M2	
6	Activity/Cost Center Code No. -----	2	
7	Subject to Price Fluctuation -----	N	
8	Related Work Category No. -----	0	
9	Item Quantity -----		62.90
10	Item Rate -----		1.00

=====

FIGURE (A-1); DATA ENTRY- BOQ ITEM DATA

```

Data Preparation Options:-
=====
Bill Items Data -----1
BOQ Valuation Data -----2
Resources Data -----3
Sub-Contractors Data -----4
Cost Center Data -----5
Sections Data -----6
Unfixed Material Data-----7
Engineer's Assessment for Price Adjustment ---8
Exit -----0

Which do you want ? 2

Valuation No. ? 1

Valuation Date (Month/Year,++/++) ? 2/88

Item Code ? 111A

Previous Quantity ? 0

Quantity Now ? 1

Valuation No. ( 1) in 2/88
=====
Item Code           : 111A
Item Quantity       :           1.000
Unit of Measurement : SUM
Item Rate           : 714.78
Bill Amount         :           714.78
Previous Quantity   :           0.00
Previous Amount     :           0.00
Quantity Now        :           1.00
Amount Now          :           714.78
Quantity to date    :           1.00
Amount to date      :           714.78
=====
AM ----- To amend
FI ----- To file
FX ----- To exit

Command ? FI
Valuation data of item 111A          filed

Is there any more items --(Y/N) ? N

```

FIGURE (A-2); DATA ENTRY- BOQ VALUATION DATA

Data Preparation Options:-

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

Which do you want ? 3

Labour Resources:-

Resource Number ? 12

Resource Description ? BRICK LAYER

Resource Unit of Measurement ? HR

Resource Rate per Unit ? 8.5

Resource overtime Rate(if there is any) ? 9.75

Res. No.	Description	Unit	Rate	Ov. rate
12	BRICK LAYER	HR	8.50	9.75

- AM-----To Amend
- FI-----To File
- QJ-----To Quit

Command ? FI

Resource Data No. 12 filed

Is there any more resources ---Y/N ? N

FIGURE (A-3); DATA ENTRY- CONTRACT RESOURCE DATA

Data Preparation Options:-

=====

- Bill Items Data -----1
- BOQ Valuation Data -----2
- Resources Data -----3
- Sub-Contractors Data -----4
- Cost Center Data -----5
- Sections Data -----6
- Unfixed Material Data-----7
- Engineer's Assessment for Price Adjustment ---8
- Exit -----9

Which do you want ? 4

Sub-Contractor Number ? 1

Sub-Contractor Name ? JOHN SMITH

Unit of Payment ? SUM

Agreed Rate per Unit ? 32.87

Sub-Cont.	Name	Unit	Rate
1	JOHN SMITH	SUM	32.87

- AM-----To Amend
- FI-----To File
- QU-----To Quit

Command ? FI

Subcontractor's Data No.(1) filed

Is there any more sub-contractors ?-Y/N N

FIGURE (A-4); DATA ENTRY SUBCONTRACTOR GENERAL DATA

```

Data Preparation Options:-
=====
Bill Items Data -----1
BOO Valuation Data -----2
Resources Data -----3
Sub-Contractors Data -----4
Cost Center Data -----5
Sections Data -----6
Unfixed Material Data-----7
Engineer's Assessment for Price Adjustment ---8
Exit -----9

Which do you want ? 5

Cost Center No. ? 3
Cost Center Code ? PROVISIONAL SUMS
Cost Center Description ? PROVISIONAL SUMS
Cost Center Unit of Measurement ? SUM
Cost Center Quantity ? 5000
Cost Center Rate ? 1

Breakdown Values of Cost Center Amount (%):-

Labour ?
Plant ?
Material ? 90
Subcontractor ?
Preliminaries ? 10
Profits/Overheads ?

Cost Center No. : 3
Cost Center Code :PROVI
Cost Center Description :PROVISIONAL SUMS
Cost Center Unit :SUM
Cost Center Quantity : 5000.00
Cost Center Rate : 1.00
Cost Center Breakdown Values :
Labour : 0.00
Plant : 0.00
Material : 90.00
Subcontractor : 0.00
Preliminaries : 10.00
Profits/Overheads : 0.00

AM ----- To Amend
FI ----- To File
FY ----- To Exit

```

FIGURE (A-5); DATA ENTRY- COST CENTER DATA

Command ? AM

Cost Center No. -----1
Cost Center Code -----2
Cost Center Description -----3
Cost Center Unit of Measurement -----4
Cost Center Quantity -----5
Cost Center Rate -----6
Breakdown Values (X) :-
 Labour -----7
 Plant -----8
 Material -----9
 Subcontractor -----10
 Preliminaries -----11
 Profits/Overheads--12

Option ? 2

Connected Cost Center Code ?

Cost Center No.	:	3
Cost Center Code	:	
Cost Center Description	:	PROVISIONAL SUMS
Cost Center Unit	:	SUM
Cost Center Quantity	:	5000.00
Cost Center Rate	:	1.00
Cost Center Breakdown Values	:	
Labour	:	0.00
Plant	:	0.00
Material	:	90.00
Subcontractor	:	-4.00
Preliminaries	:	10.00
Profits/Overheads	:	0.00

AM ----- To Amend
FI ----- To File
FX ----- To Exit

Command ? FI

Activist No. 3 filed.

Is there any more cost centers ---Y/N ? N

FIGURE (A-6); DATA MAINTENANCE- COST CENTER DATA

Data Preparation Options:-

=====

- Bill Items Data -----1
- BOQ Valuation Data -----2
- Resources Data -----3
- Sub-Contractors Data -----4
- Cost Center Data -----5
- Sections Data -----6
- Unfixed Material Data-----7
- Engineer's Assessment for Price Adjustment ---8
- Exit -----9

Which do you want ? 6

Bill Section Number ? 1

Bill Section Description ? TEMPORARY ACCOMMODATION

Bill Section Amount ? 230125.750

Bill Section No. : 1
Bill Section Description : TEMPORARY ACCOMMODATION
Bill Section Amount : 230125.75

AM -----To amend
FI -----To file
FX -----To exit

Option ?

FIGURE (A-7); DATA ENTRY- BOQ SECTION DATA

Data Preparation Utilities

- Bill Items Data -----1
- BOB Valuation Data -----2
- Resources Data -----3
- Sub-Contractors Data -----4
- Cost Center Data -----5
- Sections Data -----6
- Unfixed Material Data-----7
- Engineer's Assessment for Price Adjustment ---8
- Exit -----9

Which do you want ? 7

Valuation No. ? 1

Material Resource No. ? 56

Quantities of Resource ? 78

Percentage to be paid for ? 85

Cost Center ? 5

Section ? 1

Is there any more unfixed materials----Y/N ? Y

Material Resource No. ? 57

Quantities of Resource ? 710

Percentage to be paid for ? 85

Cost Center ? 5

Section ? 2

Is there any more unfixed materials----Y/N ? N

VALUATION NO. 1 UNFIXED MATERIALS

MAT NO.	DESCRIPTION	QUANTITY	UNIT	RATE	PROP
56	MILD STEEL 20MM DIA.	78.00	M3	259.35	85.0
57	MILD STEEL 25MM DIA.	710.00	M3	215.25	85.0

END OF UNFIXED MATERIALS

- MD -----To append
- FI -----To file
- EX -----To exit

Option ? FI

Unfixed Materials filed ...!

FIGURE (A-8); DATA ENTRY - UNFIXED MATERIAL VALUATION DATA

Data Preparation Options:-

=====

- Bill Items Data -----1
- BOB Valuation Data -----2
- Resources Data -----3
- Sub-Contractors Data -----4
- Cost Center Data -----5
- Sections Data -----6
- Unfixed Material Data-----7
- Engineer's Assessment for Price Adjustment ---8
- Exit -----9

Which do you want ? 8

Contract No. ? 1

Engineer's Assessment of The Breakdown of The Contract Value

Item	Σ
Labour	<u>35</u>
Plant	<u>36</u>
Aggregates	<u>12</u>
Bricks and Clay Products	<u>3</u>
Cements	<u>2</u>
Cast Iron Products	<u>0</u>
Coated Roadstone	<u>1</u>
DERV Fuel	<u>2</u>
Gas Oil Fuel	<u>0</u>
Timber generally	<u>0</u>
Reinforcement Steel	<u>9</u>
Metal Sections	<u>0</u>
Structural Steel	<u>0</u>
Steelwork Labours	<u>0</u>

Assumed Percentage of Non-Adjustment Elements (Σ) ? 10

Is there any amendment ?-Y/N N

Engineer's Assessment of The Breakdown of The Value of Contract No(1) filed

FIGURE (A-9); DATA ENTRY - ENGINEER'S ASSESSMENT FOR PRICE ADJUSTMENT

APPENDIX (B)

FIGURES (1-9); SHOW THE SITE SHEETS WHICH ARE
USED IN CONTROLLING LABOUR
RESOURCES ON SITE, FOR BOTH TYPE
OF CONTRACTS (BUILDING AND CIVIL
ENGINEERING) .

DAILY LABOR REPORT

CONTRACT DESCRIPTION: INTERBELT 70 SEC D NO 10 REPORT NO: 10-11-24
 FOREMAN: HARRY CRAMER DATE: 11/24/84, M T W T F S S

NAME	EMPLOYEE'S		RATE	LINE ITEM NUMBER	DESCRIPTION OF WORK PERFORMED										EMPLOYEE ST.	TOTALS P T
	NO	UNION			HOURS	HOURS	HOURS	HOURS	HOURS	HOURS	HOURS	HOURS	HOURS	HOURS		
1	2	3	4	5	6	7	8	9	10	11	12	13				
JOHN AUSTIN	59	LAB	\$12.00	000	3									\$36.00		
JOHN BUTHER	77	OPER.	\$18.00	001		9								\$162.00		
HARVY DAVIS	42	OPER.	\$18.00	003			10							\$180.00		
RON HERMAN	36	OPER.	\$16.00	002				4						\$64.00		
CURT MODER	60	OPER.	\$18.00	001					9					\$162.00		
SAM SMITH	61	OPER.	\$16.00	001					9					\$144.00		
NOLAN TUCKER	80	TMSTR	\$14.00	002						3				\$42.00		
CALVIN WILSON	72	OPER.	\$16.00	002								9		\$144.00		
TOTALS					3	9	10	4	18	3				\$434.00		

FIGURE (B-3); A SAMPLE OF A DAILY LABOUR SITE REPORT



WEEK ENDING _____

CO. No:

M	N
---	---

EMPLOYEE NAME: _____

EMPLOYEE No:

--	--	--	--	--	--	--	--	--	--

SPECIAL DETAILS	PAYMENTS	DEDUCTIONS	AMOUNT APPROVED	OFFICE USE

CONTRACT/ No./JOB	DAILY HOURS TOTAL															Appro. by F/Man	
	N	OT 1	OT 2	OT 3	N	OT 1	OT 2	OT 3	N	OT 1	OT 2	OT 3	N	OT 1	OT 2		OT 3
TUESDAY																	
WEDNESDAY																	
THURSDAY																	
FRIDAY																	
SATURDAY																	
SUNDAY																	
MONDAY																	
CORES	02	03	04	05	02	03	04	05	02	03	04	05	02	03	04	05	
TOTAL HOURS																	

H - Normal Time
 OT 1 - First Hour
 OT 2 - Second Hour onwards and Saturday to 5:00 p.m.
 OT 3 - Saturdays after 5:00 p.m. and Sundays

Approved for punching
 Signature _____

FIGURE (B-6); A SAMPLE OF A WEEKLY TIME SHEET

AREA OFFICE WEEKLY TIME SHEET

Contract _____

Week Ending _____

4/LG 12/C

REG. No. OCC NAME	Back Time	MON	TUES	WED	THURS	FRI	SAT	SUN	Total Time	Rate	Bonus	Trev Time per Day	Tool Money	L/A	Fares per Day	Total Subs for Week	REMARKS	
	A Actual Hours Worked																	
	B Wet Time Payable																	
	A Actual Hours Worked																	
	B Wet Time Payable																	
	A Actual Hours Worked																	
	B Wet Time Payable																	
	A Actual Hours Worked																	
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	A Actual Hours Worked																	
	B Wet Time Payable																	
	A Actual Hours Worked																	
	B Wet Time Payable																	
	A Actual Hours Worked																	
	B Wet Time Payable																	

B WET TIME PAYABLE - HALF TIME LOST (To be shown in Red)
 NEW STARTS AND PAY OFFS To be shown in remarks col. New start date paid off date
 BONUS COL To be completed by agent only (Total to be written in)
 MAINTENANCE TIME To be recorded in line "B"
 Duplicate Copy to be kept on file

Signed _____

FIGURE (B-8); A SAMPLE OF AN AREA OFFICE WEEKLY TIME SITE SHEET

APPENDIX (C)

FIGURES (1-9); SHOW THE DATA ENTRY OF "LABOUR CONTROL ON SITE" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF THE USER INPUT.

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1
Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.
55 MANSFIELD ROAD
DERBY
DERBYSHIRE
UNITED KINGDOM
ARCHITECT/ENGINEER: JERARD WOLKER
57 BUCKINGHAM DRIVE
DERBY,
DERBYSHIRE,
UNITED KINGDOM
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

*****< Main Menu >*****

Options:-

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

Which do you want ? 3

FIGURE (C-1); SYSTEM ENTRY - SELECTION OF "LABOUR CONTROL"
FUNCTION FROM THE MAIN MENU.

 Individual Labour System ----- 1
 Labourers in Gang System ----- 2
 East ----- 3

Which one is operating ? 1

Week No. ? 1

Week Ending (dd/mm/yy) ? 2/2/88

Labour Resource No. ? 1

Related Item Code ? 111B

Related Activity/Cost Center Code No. ? 1

Weekly Total Worked Hours ? 40

Weekly Overtime Hours (if there are any) ?

Any Extra Payments for this Resource (in pounds)?

This Week Measurements ? 1

Is there any more resources in this week ?-Y/N Y

Labour Resource No. ? 2

Related Item Code ? 111C

Related Activity/Cost Center Code No. ? 1

Weekly Total Worked Hours ? 20

Weekly Overtime Hours (if there are any) ?

Any Extra Payments for this Resource (in pounds)?

This Week Measurements ? 2

Is there any more resources in this week ?-Y/N Y

Labour Resource No. ? 23

Related Item Code ? 111E

Related Activity/Cost Center Code No. ? 1

Weekly Total Worked Hours ? 40

Weekly Overtime Hours (if there are any) ?

Any Extra Payments for this Resource (in pounds)?

This Week Measurements ? 1

Is there any more resources in this week ?-Y/N N

WEEKLY LABOUR TIME SHEET

WEEK NO.: 1
 WEEK ENDING: 2/2/88

LAB. NO.	REL. ITEM CODE	CENT. NO.	TOT. HRS	OV/T HRS	EXT. PAY	QUANTITY
1	111B	1	40.00	0.00	0.00	1.00
2	111C	1	20.00	0.00	0.00	2.00
23	111E	1	40.00	0.00	0.00	1.00

00 ----- To amend
 01 ----- To file
 02 ----- To delete

FIGURE (C-2); DATA ENTRY- WEEKLY LABOUR TIME SHEET FOR INDIVIDUAL LABOUR SYSTEM.

```

Week No. ----- 1
Week Ending Resource No. ----- 2
Labour Resource No. ----- 3
Related Item Code ----- 4
Related Activity/Cost Center Code ----- 5
Weekly Total Worked Hours ----- 6
Overtime Hours ----- 7
Extra Payments ----- 8
This Week Measurements ----- 9
Exit ----- 10

```

Which one to amend ? 3

Required Resource No. ? 1

Connected Labour Resource No. ? 43

WEEKLY LABOUR TIME SHEET
=====

WEEK NO.: 1
WEEK ENDING: 2/2/88

LAB. NO.	RE. ITEM CODE	CENT. NO	TOT. HRS	OV/T HRS	EXT. PAY	QUANTITY
43	111B	1	40.00	0.00	0.00	1.00
2	111C	1	20.00	0.00	0.00	2.00
23	111E	1	40.00	0.00	0.00	1.00

AM ----- To amend
FI ----- To file
EX ----- To exit to previous menu

Which one do you want ? FI

Weekly Labour Time Sheet of Week No. (1) filed....

Is there any more weekly time sheets ?-Y/N N

FIGURE (C-3); DATA MAINTENANC - WEEKLY LABOUR TIME SHEET DATA.

LABOUR CONTROL OPTIONS:

- 1
- Editing Weekly Labour Time Sheets ----- 1
- View Weekly Manforce Worked Hours Reports ----- 2
- View Weekly Manforce Payments Reports ----- 3
- Exit ----- 4

Which one do you want ? 2

Which week no. the report required on ? 1

WEEKLY LABOUR TIME SHEET-VIEW REPORT

=====

WEEK NO.: 1 WEEK ENDIGN: 2/2/88

RES. NO.	RE. ITEM CODE	ACT. NO.	TOT. HRS	OVR. HRS	EXT. PAY.
1	111B	1	40.00	0.00	0.00
2	111C	1	20.00	0.00	0.00
23	111E	1	40.00	0.00	0.00
25	223A	4	40.00	0.00	0.00
31	223A	4	40.00	0.00	0.00
24	223B	4	38.00	0.00	0.00

Press <CR> to go back to the previous menu

FIGURE (C-4); WEEKLY LABOUR TIME SHEET ON-SCREEN REPORT

LABOUR CONTROL OPTIONS:

=====

- Editing Weekly Labour Time Sheets ----- 1
- View Weekly Manforce Worked Hours Reports ----- 2
- View Weekly Manforce Payments Reports ----- 3
- Exit ----- 4

Which one do you want ? 3

Are Bonusing Schemes operating ?-Y/N N

Which Week No. the report required on ? 1

WEEKLY MANFORCE PAYMENT-VIEW REPORT

=====

WEEK NO.: 1

WEEK ENDING: 2/2/88

RES. NO.	ACT. NO.	BASIC COST	EXTR. COST	TOTAL COST
1	1	170.00	0.00	170.00
2	1	164.00	0.00	164.00
23	1	208.00	0.00	208.00
25	4	310.00	0.00	310.00
31	4	200.00	0.00	200.00
24	4	313.50	0.00	313.50

Press <CR> to go back to the previous menu

FIGURE (C-5); WEEKLY MANFORCE PAYMENT ON-SCREEN REPORT FOR INDIVIDUAL LABOUR SYSTEM.

WORKING LABOUR SYSTEMS:

- Individual Labourers System ----- 1
- Labourers in Gangs System ----- 2
- Exit ----- 3

Which one is operating ? 2

Week No. ? 1

Week Ending Date (dd/mm/yy) ? 2/2/88

Gang No. ? 1

Related Item Code ? 111D

Related Activity/Cost Center Code ? 1

This Week O.S. Measurement ? 1

Labour Resource No. ? 1

Weekly Total Worked Hours ? 1

Weekly Overtime Hours (if there are any) ?

Any Extra Payment for Gang (in pounds) ?

Is there any more labourers in this gang ?-Y/N Y

Labour Resource No. ? 2

Weekly Total Worked Hours ? 1

Weekly Overtime Hours (if there are any) ?

Any Extra Payment for Gang (in pounds) ?

Is there any more labourers in this gang ?-Y/N Y

Labour Resource No. ? 23

Weekly Total Worked Hours ?

Weekly Overtime Hours (if there are any) ?

Any Extra Payment for Gang (in pounds) ?

Is there any more labourers in this gang ?-Y/N N

WEEKLY GANG TIME SHEET

WEEK NO.: 1

WEEK ENDING: 2/2/88

GANG NO.: 1

RELATED ITEM (111D) : SERVICING OF MOBILE OFFICE TYPE 1 FOR THE ENGINEER UNTIL COMPLETION

RELATED ACTIVITY (11): TEMPORARY ACCOMMODATION

RES. NO.	TOTAL HOURS	OVERTIME	EXT. PAYMENT	QUANTITY
1	1.00	0.00	0.00	1.00
2	1.00	0.00	0.00	1.00
23	0.00	0.00	0.00	1.00

AM ----- To amend

FI ----- To file

EX ----- To exit to the previous menu

Which one do you want ? AM

FIGURE (C-6); DATA ENTRY - WEEKLY LABOUR TIME SHEET FOR GANGS

Week No. ----- 1
 Week Ending ----- 2
 Gang No. ----- 3
 Related Item Code ----- 4
 Related Activity/Cost Center ----- 5
 Labour Resource No. ----- 6
 Weekly Total Worked No. ----- 7
 Overtime Hours ----- 8
 Extra Payment ----- 9
 This Week Measurement ----- 10
 Exit ----- 11

Which one do you want ? 4

Corrected Related Item Code ? 111R

WEEKLY GANG TIME SHEET

WEEK NO.: 1
 WEEK ENDING: 2/2/88
 GANG NO.: 1
 RELATED ITEM (111R): SERVIVING OF PRINCIPLE OFFICE FOR THE ENGINEER UNTIL COMPLETION OF THE WORKS
 RELATED ACTIVITY (1): TEMPORARY ACCOMMODATION

RES. NO.	TOTAL HOURS	OVERTIME	EXT. PAYMENT	QUANTITY
1	40.00	0.00	0.00	1.00
2	51.00	0.00	0.00	1.00
23	42.00	0.00	0.00	1.00

AM ----- To amend
 FI ----- To file
 FX ----- To exit to the previous menu

Which one do you want ? FI

Weekly Time Sheet of Week No.(1)filed..

FIGURE (C-7); DATA MAINTENANCE - WEEKLY LABOUR TIME SHEET DATA

LABOUR CONTROL OPTIONS:

=====

- Editing Weekly Labour Time Sheets ----- 1
- View Weekly Manforce Worked Hours Reports ----- 2
- View Weekly Manforce Payments Reports ----- 3
- Exit ----- 4

Which one do you want ? 2

Which week no. the report required on ? 1

WEEKLY GANG TIME SHEET-VIEW REPORT

=====

WEEK NO.:	RE. ITEM CODE	ACT. NO.	RES. NO.	TOT. HR	OVERTIME	EXT. PAY.
1	111R	1	1	40.00	0.00	0.00
			2	20.00	0.00	0.00
			23	40.00	0.00	0.00

WEEK ENDING: 2/2/88

Press <CR> to go back to the previous menu

FIGURE (C-8); WEEKLY GANG TIME SHEET AS ON-SCREEN REPORT

LABOUR CONTROL OPTIONS:

- 1
- Editing Weekly Labour Time Sheets ----- 1
- View Weekly Manforce Worked Hours Reports ----- 2
- View Weekly Manforce Payments Reports ----- 3
- Exit ----- 4

Which one do you want ? 3

Are Bonusing Schemes Operating ?-Y/N Y

Which Week No. the report required on ? 1

WEEKLY MANFORCE PAYMENT-VIEW REPORT

WEEK NO.: 1 WFFK ENDING: 2/2/88

RES. NO.	ACT. NO.	BASIC COST	EXT. COST	BONUS COST	TOTAL COST
1	1	170.00	0.00	4.04	174.04
2	1	328.00	0.00	343.58	671.58
23	1	208.00	0.00	4.94	212.94
25	4	310.00	0.00	809.87	1119.87
31	4	200.00	0.00	-72.50	127.50
24	4	313.50	0.00	37.13	350.63

Press <CR> to go back to the previous menu

FIGURE (C-9); WEEKLY MANFORCE PAYMENT ON-SCREEN REPORT

APPENDIX (D)

FIGURES (1-6); SHOW THE BONUSING SHEETS USED ON
SITE BY THE CONSTRUCTION COMPANIES

SECTION		BLOCKWORK		TOTAL VALUE				TOTAL TARGET	
NO	DESCRIPTION	U/L	TARGET	QUANTITY	L A B	EXTENSION	P L A H	EXTENSION	TOTAL TARGET
	1.5 WALL 1.5 COURSE	m ²	60 m ² /100	35	19	321.65			252.00
	2.5 WALL 2.5 COURSE	m ²	70 m ² /100	30	20	301.20			252.00
	DITTO BOTH SIDES	m ²	100 m ² /100	44	10.7	479.60			422.40
	CONCRETE PAVEMENT								
	5.5 WALL 5.5 COURSE	m ²	140 m ² /100	26	23.25	267.27			655.20
	11.5 WALL 11.5 COURSE	m ²	60 m ² /100	9	9.6	432.42			838.40
	DITTO CASE 11.5 COURSE	m ²	75 m ² /100	8	7.0	56.07			337.5
	DITTO TAPPING AC								
	PER 7.5 H 8.5 WALL								
	AC BASE 10.2 WALL	m ²	140 m ² /100	22	29.7	654.00			554.40
	1.5 WALL E.W.C.	m ²	80 m ² /100	12	10.1	121.20			115.20
	11.5 WALL 11.5 FACINGS	m ²	80 m ² /100	1234	5.41	6992.74			5732.20
	DITTO CASE COLUMN	m ²	140 m ² /100	379	5.95	2255.39			4725.60
	BRICKS 20 MI								
	STRETCHER BOTTOM								
	CUT HEADS	m ²	200 m ²	1.2	226	253.12			220.00
	E.O. END	m ²	150 m ²	66	42	2772			1992
	E.O. ANGLE	m ²	150 m ²	11	17.2	680			1140
	FRESH SURFACE								
	2.5 MI W.D.P.	m ²	120 m ²	628	13.6	854.07			785.00
	SOLARIES PER COURSE								
	FURNACE PER T2								
	TAPPING PER PER 6.5								
	AC BASE (10.2 WALL) CASE	m ²	100 m ²	209	1.00	269.00			269.00
	E.O. ANGLE DITTO	m ²	30 m ²	780	3.4	265.20			234.00
	100 - BRICKS	m ²	200 m ²	1173	2.3	2639.74			2340.00
	DITTO PER ONE SIDE	m ²	250 m ²	1021	2.52	2572.92			2852.50
	DITTO (CASE) PER 10.2	m ²	200 m ²	21	4.2	567.64			175.00
	100 BRICKS PER 3.0 SIDE	m ²	300 m ²	23	2.9	66.93			69.00
	150 - BRICKS	m ²	250 m ²	119	2.7	353.40			222.50
	CARRYING FORWARD					20158.57			1202.15

FIGURE (D-3); A SAMPLE OF BONUS CALCULATION SHEET (STANDARD BONUS SYSTEM)

- A HOURS WORKED
- B N/P OVERTIME
- C G. MINIMUM

TIMEBOOK/BONUS BOOK

CONTRACT..... WEEK ENDING.....

6/11/004 Rev 9/77

NAME		ADJS	M	T	W	T	F	S	S	TOTAL HOURS	BONUS	TT	SERVICE & ALLOC
OCCUP. /CLOCK No.													
A													
B													
C													
A													
B													
C													
A													
B													
C													
A													
B													
C													
A													
B													
C													
A													
B													
C													
A													
B													
C													

FIGURE (D-5); A SAMPLE OF TIMEBOOK/BONUS BOOK SITE SHEET

BONUS ASSESSMENT AND COST VALUE COMPARISON

CONTRACT No. _____ FRAME No. _____ SHEET No. _____

SITE COPY

NAME	TOTAL HOURS AND PAYABLES		ALLIANCE OF HOURS		BONUS ASSESSMENT					BONUS AND VALUE					TOTAL VALUE	TOTAL COST	TOTAL VALUE/COST	TOTAL HOURS	TOTAL COST/HOUR
	FRAME	PAYABLES	TOTAL HOURS	BVA	MEASURE COST	MEASURE COST/BONUS	UNIT VALUE	UNIT VALUE/BONUS	TOTAL VALUE	TOTAL VALUE/BONUS	MEASURE COST	MEASURE COST/BONUS	TOTAL VALUE	TOTAL VALUE/BONUS					
1																			
2																			
3																			
4																			
5																			
6																			
7																			
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95																			
96																			
97																			
98																			
99																			
100																			

QUANTITY: _____
 CLASS INCL: _____
 AP PRAD: _____
 DATE: _____
 SITE MANAGER: _____
 APPROVE: _____
 DATE: _____

FIGURE (D-6); A SAMPLE OF BONUS ASSESSMENT SITE SHEET

APPENDIX (E)

FIGURES (1-5); SHOW THE DATA ENTRY OF "BONUSING INDICES" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF THE USER INPUTS.

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1
PROJECT: BALFOUR BEATTY CONSTRUCTION CGS SYSTEM
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.
55 MANSFIELD ROAD
DERBY
DERBYSHIRE
UNITED KINGDOM
ARCHITECT/ENGINEER: JERARD WOLKER
57 BUCKINGHAM DRIVE
DERBY,
DERBYSHIRE,
UNITED KINGDOM
TYPE OF THE WORK: BUILD

Press <CR> to go into the system.

****< Main Menu >****

Options:-

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

Which do you want ? 2

FIGURE (E-1); FUNCTION SELECTION FROM THE MAIN MENU

FINANCIAL INCENTIVE SCHEMES:-

- Piecework Scheme ----- 1
- Standard Bonus Scheme ----- 2
- Sharing Profit Scheme ----- 3
- Exit ----- 4

=====

Which scheme is operating ? 1

Activity/Cost Center Code No. ? 1

Bonus Target(hours/unit of measurement) ? 220

Additions for Daywork Consideration(as %)? 10

Any more activities involved ?-Y/N Y

Activity/Cost Center Code No. ? 2

Bonus Target(hours/unit of measurement) ? 178

Additions for Daywork Consideration(as %)? 10

Any more activities involved ?-Y/N Y

Activity/Cost Center Code No. ? 4

Bonus Target(hours/unit of measurement) ? 198

Additions for Daywork Consideration(as %)? 10

Any more activities involved ?-Y/N N

PIECEWORK INCENTIVE SCHEME

=====

ACT. CODE	TARGET	ADD. %
1	220.00	10.00
2	178.00	10.00
4	198.00	10.00

=====

AM ----- To amend

FI ----- To file

FX ----- To exit to the previous menu

Option ?

FIGURE (E-2); DATA ENTRY - PIECEWORK BONUS SYSTEM DATA

Activity/Cost Center Code No. ----- 1
Bonus target ----- 2
Addition for Daywork Consideration ----- 3

Which do you want to amend ? 3

Which activity/cost center to work on ? 1

Corrected Additions for Daywork (as %) ? 10

PIECEWORK INCENTIVE SCHEME

=====

ACT. CODE	TARGET	ADD. %
1	1.00	10.00
2	128.00	10.00
3	198.00	10.00

=====

AA ----- To amend
FI ----- To file
EI ----- To exit to the previous menu

Option ? FI

Piecework Incentive Scheme Data filed, press <CR>.

FIGURE (E-3); DATA MAINTENANCE - PIECEWORK BONUS SYSTEM DATA.

FINANCIAL INCENTIVE SCHEMES:-

- Piecework Scheme ----- 1
- Standard Bonus Scheme ----- 2
- Sharing Profit Scheme ----- 3
- Exit ----- 4

Which scheme is operating ? 2

Labour Resource No. ? 1

Bonus Target(hours/unit of measurement)? 10

Standard Bonus Unit ? 30

Is there any more resource ?-Y/N Y

Labour Resource No. ? 2

Bonus Target(hours/unit of measurement)? 15

Standard Bonus Unit ? 45

Is there any more resource ?-Y/N N

STANDING INCENTIVE SCHEME

LAB. NO.	TARGET	BONUS
1	10.00	30.00
2	15.00	45.00

- AM ----- To amend
- FI ----- To file
- EX ----- To exit to the previous menu

Which do you want ? FI

Standard Bonus Scheme Data filed, press<CR>

FIGURE (E-4); DATA ENTRY - STANDARD BONUS SCHEME DATA

FINANCIAL INCENTIVE SCHEMES:-

- Piecework Scheme ----- 1
- Standard Bonus Scheme ----- 2
- Sharing Profit Scheme ----- 3
- Exit ----- 4

Which scheme is operating ? 3

Related Activity/Cost Center Code No. ? 1

Gang No. ? 3

Total Gang Weekly Working Hours ? 160

Bonus Target (pounds/unit) ? 143

Any more Gangs involved ?-Y/N Y

Related Activity/Cost Center Code No. ? 5

Gang No. ? 2

Total Gang Weekly Working Hours ? 158

Bonus Target (pounds/unit) ? 542

Any more Gangs involved ?-Y/N Y

Related Activity/Cost Center Code No. ? 6

Gang No. ? 4

Total Gang Weekly Working Hours ? 159

Bonus Target (pounds/unit) ? 450

Any more Gangs involved ?-Y/N N

SHARING PROFIT INCENTIVE SCHEME

ACT. NO.	GANG NO	TARGET	GANG HRS
1	3	143.00	160.00
5	2	542.00	158.00
6	4	450.00	159.00

- AK ----- To amend
- FI ----- To file
- FY ----- To exit to the previous menu

Option ? FI

Sharing Profit Scheme Data filed, press <CR>

FIGURE (E-5); DATA ENTRY - SHARING PROFIT SCHEME DATA

APPENDIX (F)

FIGURES (1-5); SHOW THE DATA ENTRY OF "ON-COST
SITE OVERHEADS" FUNCTION WITH
ITS ON-SCREEN REPORTS, AS
DIALOGUES BETWEEN THE USER AND
"PLUS COSTS". THE UNDERLINED TEXT
ARE SAMPLES OF THE USER INPUTS.

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.
55 MANSFIELD ROAD
DERBY
DERBYSHIRE
UNITED KINGDOM
ARCHITECT/ENGINEER: JERARD WOLKER
57 BUCKINGHAM DRIVE
DERBY,
DERBYSHIRE,
UNITED KINGDOM
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

****< Main Menu >****

Options:-

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

Which do you want ? 8

FIGURE (F-1); FUNCTION SELECTION FROM THE MAIN MENU OF THE SYSTEM

ON-COST OVERHEAD PAYMENTS:-
 =====

- Editing Weekly Overhead Payments ----- 1
- View Weekly Calculation Reports ----- 2
- View Monthly Calculation Reports ----- 3
- Exit ----- 4

Which one do you want ? 1

Week No. ? 2/2/88

Week No. ? 1

Week Ending Date(dd/mm/yy) ? 2/2/88

On-Cost Overhead Payments:-
 =====

Plus Rates:12.65

Non-Productive Overtime:12.75

Public Holidays:9.85

Sick Pay:7.09

Inclement Weather Time:5.85

Travel Time:3.53

Graduated National Insurance:21.96

Redundancy and Training Levy:14.5

Fares:43.75

Subsistence:21.65

Holiday Stamps:0

Miscellaneous Payments:43.97

Week No.: 1

Week Ending:2/2/88

On-Cost Overhead Payments:-

1- Plus Rates:	12.65
2- Non-Productive Overtime:	12.75
3- Public Holidays:	9.85
4- Sick Pay:	7.09
5- Inclement Weather Time:	5.85
6- Travel Time:	3.53
7- Graduated National Insurance:	21.96
8- Redundancy and Training Levy:	14.50
9- Fares:	43.75
10- Subsistence:	21.65
11- Holiday Stamps:	0.00
12- Miscellaneous Payments:	43.97

=====

AM ----- To amend

FI ----- To file

FX ----- To exit to the menu

Option ? AM

FIGURE (F-2); DATA ENTRY - WEEKLY ON-COST OVERHEAD PAYMENTS
 DATA


```

AMENDMENT OPTIONS:-
      Week No. ----- 1
      Week Ending Date ----- 2
      On-Cost Figures ----- 3
Which one to amend ? 1
Corrected Week No. ? 1

Week No.: 1                               Week Ending:2/2/88

On-Cost Overhead Payments:-
-----
1- Plus Rates:                            12.65
2- Non-Productive Overtime:                12.75
3- Public Holidays:                        9.85
4- Sick Pay:                               7.09
5- Inclement Weather Time:                5.85
6- Travel Time:                            3.53
7- Graduated National Insurance:          21.96
8- Redundancy and Training Levy:           14.50
9- Fares:                                  43.75
10-Subsistence:                            21.65
11-Holiday Stamps:                         0.00
12-Miscellaneous Payments:                 43.97
=====
AY ===== To add
FY ----- To exit to the menu
Option ? F1
On-Cost Overhead Payments of Week ( 1) filed...

```

FIGURE (F-3); DATA MAINTENANCE - WEEKLY ON-COST OVERHEAD PAYMENTS DATA

ON-SITE OVERHEADS OPTION:-

=====

- Editing Weekly Overhead Payments ----- 1
- View Weekly Calculation Reports ----- 2
- View Monthly Calculation Reports ----- 3
- Exit ----- 4

Which one do you want ? 2

Required Week No. ? 1

WEEKLY ON-COST OVERHEADS-VIEW REPORTS

=====

WEEK NO.: 1

WEEK ENDING:2/2/88

OVERHEAD'S DESCRIPTION	PAYMENT
Plus Rates	12.65
Non-Productive Overtime	12.75
Public Holidays	9.85
Sick Pay	7.09
Incident Weather Time	5.85
Travel Time	3.53
Graduated National Insurance	21.96
Redundancy and Training Levy	14.50
Fares	43.75
Subsistence	21.65
Holidays Stamps	0.00
Miscellaneous Payments	43.97

=====
Press <CR>, to go back to the previous menu.

FIGURE (F-4); WEEKLY ON-COST OVERHEADS ON-SCREEN REPORT

ON-SITE OVERHEADS OPTION:-

=====

- Editing Weekly Overhead Payments ----- 1
- View Weekly Calculation Reports ----- 2
- View Monthly Calculation Reports ----- 3
- Exit ----- 4

Which one do you want ? 3

Month Date (mm/yy) ? 2/88

MONTHLY ON-COST OVERHEADS PAYMENTS-VIEW REPORTS

=====

MONTH DATE:2/88

OVERHEAD'S DESCRIPTION	PAYMENT
Plus Rates	0.00
Non-Productive Overtime	0.00
Public Holidays	0.00
Sick Pay	0.00
Incident Weather Time	0.00
Travel Time	0.00
Graduated National Insurance	0.00
Redundancy and Training Levy	0.00
Fares	0.00
Subsistence	0.00
Holiday Stamps	0.00
Miscellaneous Payments	0.00

Press <CR>, to go back to the previous menu.

FIGURE (F-5); MONTHLY ON-COST OVERHEADS ON-SCREEN REPORT

APPENDIX (G)

FIGURE (1-6); SHOW THE SITE SHEET USED FOR
CONTROLLING THE PLANT COST
AND PERFORMANCE ON SITE MANUALLY

WEEKLY PLANT RECORD

CONTRACT:-

WEEK COMMENCING:-

WEEK No:-

No.	TYPE/CAPACITY	M.	T.	W.	TH.	F.	SAT.	SUN

FIGURE (G-1); A SAMPLE OF WEEKLY PLANT RECORD SITE SHEET

DAILY PLANT RETURN						
Contract			W/E			
Contract No.			Week No.			
Plant Description			Type of Fuel	Driver		
No.	Size	Type		Date		
Description of Work			Hours			Cost Code
			Wkg.	Stdg.	Broke	
			Totals			
Weather- Remarks-			Foreman			

FIGURE (G-2); A SAMPLE OF DAILY PLANT RETURN SITE SHEET

DATE	LATRINES @ 25p/wk £	THEODOLITE @ 50p/wk £	LEVEL @ 40p/wk £	HAMMER @ 60p/wk £	SAW BENCH @ 2.25p/wk £	TOTAL £
7/3/82	0.25	0.50	0.40		2.25	3.40
14/3/82				0.40		4.00
21/3/82			0.40			3.60
28/3/82						3.60
4/4/82	0.25					1.85
11/4/82			0.40	0.40		3.40

FIGURE (G-5) SITE SHEET USED FOR CALCULATING THE SMALL PLANT ITEMS

ANY FIRM & SON LTD		CONTRACT					
DAILY TIME ALLOCATION SHEET							
NAME	P. Muller (D-1)	T. Hennessy (HIM)	J. RB				TOTALS
Excavate basement	4	4	•				
Excavate lift base	5	5	5				

FIGURE (G-6); DAILY TIME ALLOCATION SHEET FOR LABOUR AND PLANT RESOURCES

APPENDIX (H)

FIGURES (1-9); SHOW THE DATA ENTRY OF "PLANT CONTROL ON SITE" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN "PLUS COST" AND THE USER. THE UNDERLINED TEXT ARE SAMPLES OF USER INPUT

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.
55 MANSFIELD ROAD
DERBY
DERBYSHIRE
UNITED KINGDOM
ARCHITECT/ENGINEER: JERARD WOLKER
57 BUCKINGHAM DRIVE
DERBY,
DERBYSHIRE,
UNITED KINGDOM
TYPE OF THE WORK: BUILD

=====
Press <CR> to go into the system.

*****< Main Menu >*****

Options:-

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

Which do you want ? 4

FIGURE (H-1); SYSTEM ENTRY - SELECTION OF PLANT CONTROL FUNCTION FROM THE MAIN MENU

```

Edit Weekly Task Sheets .....
View Weekly Task Sheets .....
View Weekly Task Sheets .....
View Weekly Plant Cost Reports .....
View Weekly Plant Utilization Reports .....
Exit .....

```

Which one do you want ? 1

Week No. ? 1

Week Ending Date (MM/DD/YY) ? 2/2/88

Plant Resource No. ? 4

Related Activity/Cost Center No. ? 1

Weekly Working Hours ? 3

Weekly Standing Hours ? 1

Weekly Breakdown Hours ? 0

Any more plant resources ?-Y/N Y

Plant Resource No. ? 10

Related Activity/Cost Center No. ? 2

Weekly Working Hours ? 5

Weekly Standing Hours ? 0

Weekly Breakdown Hours ? 1

Any more plant resources ?-Y/N Y

Plant Resource No. ? 12

Related Activity/Cost Center No. ? 2

Weekly Working Hours ? 10

Weekly Standing Hours ? 2

Weekly Breakdown Hours ? 1

Any more plant resources ?-Y/N Y

Plant Resource No. ? 46

Related Activity/Cost Center No. ? 2

Weekly Working Hours ? 5

Weekly Standing Hours ? 0

Weekly Breakdown Hours ? 0

Any more plant resources ?-Y/N Y

Plant Resource No. ? 46

Related Activity/Cost Center No. ? 4

Weekly Working Hours ? 4

Weekly Standing Hours ? 0

Weekly Breakdown Hours ? 0

Any more plant resources ?-Y/N 0

WEEKLY PLANT TASK SHEET

WEEK NO.	1	WEEK ENDING: 2/2/88			
RES. NO.	ACT. NO.	WORKED HRS.	STANDING HRS	BREAKDOWN HRS	
4	1	3.00	1.00	0.00	
10	2	5.00	0.00	1.00	
12	2	10.00	2.00	1.00	
46	2	5.00	0.00	0.00	
46	6	4.00	0.00	0.00	

AA ----- To add
 F1 ----- To fill
 .. ----- To

FIGURE (H-2); DATA ENTRY - WEEKLY PLANT TASK SHEET

Week No. ----- 1
 Week Ending ----- 2
 Resource No. ----- 3
 Related Activity/Cost Center -- 4
 Weekly Working Hours ----- 5
 Weekly Standing Hours ----- 6
 Weekly Breakdown Hours ----- 7

Which one to amend ? 7

Whose breakdown hours to amend ? 46

Corrected Weekly Breakdown Hours ? 1

WEEKLY PLANT TASK SHEET
 =====

WEEK NO.:	WEEK ENDING: 2/2/88				
RES. NO.	ACT. NO.	WORKED HRS.	STANDING HRS	BREAKDOWN HRS	
4	1	3.00	1.00	0.00	
10	2	5.00	0.00	1.00	
12	2	10.00	2.00	1.00	
48	2	5.00	0.00	0.00	
46	6	4.00	0.00	1.00	

AM ----- To amend
 FI ----- To file
 EX ----- To exit to previous menu

Option ? FI

Weekly Plant Task Sheet of Week No.(1) filed...

FIGURE (H-3); DATA MAINTENANCE - WEEKLY PLANT TASK
 SHEET DATA

Weekly Worked Hours ? 4
 Weekly Operating Costs (running & overheads) ? 15
 Any Extra Costs ? 0
 Is there any more resources ? Y/N Y
 Plant Resource No. ? 10
 Related Activity/Cost Center No. ? 1
 Dedication Percentage (%) ? 90
 Weekly Worked Hours ? 0
 Weekly Operating Costs (running & overheads) ? 10
 Any Extra Costs ? 0
 Is there any more resources ? Y/N Y
 Plant Resource No. ? 12
 Related Activity/Cost Center No. ? 2
 Dedication Percentage (%) ? 100
 Weekly Worked Hours ? 13
 Weekly Operating Costs (running & overheads) ? 20
 Any Extra Costs ? 0
 Is there any more resources ? Y/N Y
 Plant Resource No. ? 40
 Related Activity/Cost Center No. ? 5
 Dedication Percentage (%) ? 90
 Weekly Worked Hours ? 10
 Weekly Operating Costs (running & overheads) ? 0
 Any Extra Costs ? 0

Is there any more resources ? Y/N Y
 Plant Resource No. ? 46
 Related Activity/Cost Center No. ? 6
 Dedication Percentage (%) ? 0%
 Weekly Worked Hours ? 4
 Weekly Operating Costs (running & overheads) ? 10
 Any Extra Costs ? 0
 Is there any more resources ? Y/N N

WEEKLY PLANT TIME SHEET

WEEK NO.: 1

WEEK ENDING: 2/2/99

NO.	RES. NO.	ACT. NO.	DEDICATION (%)	WORKING HRS.	OPERATING COST	EXTRA COST
1	4	10	90.00	4.00	15.00	0.00
2	10	1	90.00	4.00	10.00	0.00
3	12	2	100.00	13.00	20.00	0.00
4	40	5	90.00	10.00	0.00	0.00
5	46	6	00.00	4.00	10.00	0.00

..... To print
 To fill
 To print on a printer

FIGURE (H-4); DATA ENTRY - WEEKLY PLANT TIME SHEET

Week No. ----- 1
 Week Ending Date ----- 2
 Plant Resource No. ----- 3
 Related Activity/Cost Center No. ----- 4
 Dedication Percentage ----- 5
 Weekly Working Hours ----- 6
 Weekly Operating Costs ----- 7
 Weekly Extra Costs ----- 8

Which one to amend ? 4

In which line no. to amend ? 1

Corrected Related Activity/Cost Center No. ? 1

WEEKLY PLANT TIME SHEET

=====

WEEK NO.: 1

WEEK ENDING: 2/2/88

NO.	RES. NO.	ACT. NO.	DEDICATION (%)	WORKING HRS.	OPERATING COST	EXTRA COST
1	4	1	80.00	4.00	15.00	0.00
2	10	1	90.00	6.00	10.00	0.00
3	12	2	100.00	13.00	20.00	0.00
4	48	6	90.00	10.00	0.00	0.00
5	46	6	95.00	4.00	10.00	0.00

AM ----- To amend
 FI ----- To file
 FI ----- To exit to previous menu

Which one do you want ? FI

Weekly Plant Time Sheet of Week No.(1) filed...

FIGURE (H-5); DATA MAINTENANCE - WEEKLY PLANT TIME SHEET DATA

PLANT CONTROL OPTIONS:

- Editing Weekly Task Sheets ----- 1
- Editing Weekly Time Sheets ----- 2
- View Weekly Task Sheets ----- 3
- View Weekly Time Sheets ----- 4
- View Weekly Plant Cost Reports ----- 5
- View Weekly Plant Utilization Reports ----- 6
- Exit ----- 7

Which one do you want ? 3

Required Report's Week No. ? 1

WEEKLY PLANT TASK SHEET

WEEK NO.: 1 WEEK ENDING: 2/2/88

RES NO	DESCRIPTION	ACT NO	URK. HRS	STD. HRS	R/D. HRS
4	CONCRETE MIXER	1	3.00	1.00	0.00
10	955 TRAXCAVATOR	2	5.00	0.00	1.00
12	BRICK LAYER	2	10.00	2.00	1.00
48	LOW LOADER	2	5.00	0.00	0.00
46	DIESEL ROLLER	6	4.00	0.00	1.00

Press <CR> to go back to previous menu.

FIGURE (H-6); WEEKLY PLANT TASK SHEET AS ON-SCREEN REPORT

PLANT CONTROL OPTIONS:

- Editing Weekly Task Sheets ----- 1
- Editing Weekly Time Sheets ----- 2
- View Weekly Task Sheets ----- 3
- View Weekly Time Sheets ----- 4
- View Weekly Plant Cost Reports ----- 5
- View Weekly Plant Utilization Reports ----- 6
- Exit ----- 7

Which one do you want ? 4

Required Report's Week No. ? 1

WEEKLY PLANT TIME SHEET-VIEW REPORT

=====

RES. NO.	DESCRIPTION	ACT. NO.	DEDICATION (%)	WORK. HRS
4	CONCRETE MIXER	1	80.00	4.00
10	955 TRAXCAVATOR	1	90.00	6.00
12	BRICK LAYER	2	100.00	13.00
48	LOW LOADER	6	90.00	10.00
46	DIESEL ROLLER	6	95.00	4.00

WEEK NO.: 1 WEEK ENDING: 2/2/88

Press <CR> to go back to previous menu..

FIGURE (H-7): WEEKLY PLANT TIME SHEET AS ON-SCREEN REPORT

PIANT CONTROL OPTIONS:

- Editing Weekly Task Sheets ----- 1
- Editing Weekly Time Sheets ----- 2
- View Weekly Task Sheets ----- 3
- View Weekly Time Sheets ----- 4
- View Weekly Plant Cost Reports ----- 5
- View Weekly Plant Utilization Reports ----- 6
- Exit ----- 7

Which one do you want ? 5

Required Report's Week No. 7 1

WEEKLY PLANT COST REPORT-VIEW REPORT

=====

RES NO.	DESCRIPTION	WEEK NO.:	ACT NO.	DEICT (X)	WORKING COST	OPERAT. COST	EXTRA COST	TOTAL COST
4	CONCRETE MIXER	1	1	80.00	50.96	15.00	0.00	52.77
10	955 TRAXCAVATOR	1	1	90.00	106.68	10.00	0.00	105.01
12	BRICK LAYER	2	100.00	110.50	20.00	0.00	0.00	130.50
48	LOW LOADER	6	90.00	229.35	0.00	0.00	0.00	206.41
46	DIESEL ROLLER	6	95.00	50.00	10.00	0.00	0.00	57.00

WEEK ENDING: 2/2/88

Press<CR> to go back to previous menu.

FIGURE (H-8); PLANT COST REPORT AS ON-SCREEN REPORT

PLANT CONTROL OPTIONS:

- Editing Weekly Task Sheets ----- 1
- Editing Weekly Time Sheets ----- 2
- View Weekly Task Sheets ----- 3
- View Weekly Time Sheets ----- 4
- View Weekly Plant Cost Reports ----- 5
- View Weekly Plant Utilization Reports ----- 6
- Exit ----- 7

Which one do you want ? 6

Required Report's Week No. ? 1

WEEKLY PLANT UTILIZATION REPORT-VIEW REPORT

=====

WEEK NO.: 1

WEEK ENDING: 2/2/88

RES NO.	DESCRIPTION	ACT NO.	DEDIC. (%)	WORKED HOURS	STAND. HOURS	B/D HOURS	UTIL. (%)	REMARK
4	CONCRETE MIXER	1	80.00	4.00	1.00	0.00	80.00	GOOD
10	955 TRAXCAVATOR	1	90.00	6.00	0.00	1.00	85.71	V. GOOD
12	BRICK LAYER	2	100.00	13.00	2.00	1.00	81.25	V. GOOD
48	LOW LOADER	6	90.00	10.00	0.00	0.00	81.25	
46	DIESEL ROLLER	6	95.00	4.00	0.00	1.00	80.00	GOOD

Press <CR> to go back to previous menu.

FIGURE (H-9); PLANT UTILIZATION REPORT AS ON-SCREEN REPORT

APPENDIX (I)

FIGURES (1-5); SHOW THE SITE SHEETS USED FOR
CONTROLLING THE MATERIAL ON SITE

MATERIALS UTILIZATION

	ITEMS				REMARKS
	G.S.B.				
DELIVERED	2000 T				
<u>LESS</u> STOCK	200 T				
QUANTITY USED (a)	1800 T				
MEASURED FOR VALUE (b)	1000 T				
YIELD = $\frac{(a)}{(b)}$	1.8 T/m				
ESTIMATORS ALLOWANCE	1.7 T/m				
GAIN/LOSS TONNES	100 T				
£	£300				

FIGURE (I-2); MATERIAL UTILIZATION CALCULATION FORM

MATERIALS WASTAGE

	ITEMS			REMARKS
	CONCRETE			
A. DELIVERED QUANTITY	720			
B. MEASURE FOR VALUE	690			
<u>GAIN/ LOSS</u>	<u>30</u>			
OTHER USES (TEMP. WORKS ETC.)	17			
C. UNACCOUNTED WASTE	13			
% GAIN/LOSS (C/B X 100)	1.8%			
ESTIMATORS WASTAGE ALLOWANCE	3 1/2%			

FIGURE (1-3); MATERAIL WASTAGE CALCULATION FORM

APPENDIX (J)

FIGURES (1-17); SHOW THE DATA ENTRY OF "MATERIAL CONTROL ON SITE" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN "PLUS COST" AND THE USER. THE UNDERLINED TEXT ARE SAMPLES OF USER INPUT

To Work on an Existing Contract -----1
To Work on a New Contract -----2
To Work on Building Construction Indices ----3
To Work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.
55 MANSFIELD ROAD
DERBY
DERBYSHIRE
UNITED KINGDOM
ARCHITECT/ENGINEER: JERARD WOLKER
57 BUCKINGHAM DRIVE
DERBY,
DERBYSHIRE,
UNITED KINGDOM
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

*****< Main Menu >*****

Options:-

Data Preparation -----1
Bonusing Indices Data -----2
Labour Control -----3
Plant Control -----4
Material Control -----5
Subcontractors Control -----6
Preliminaries Control -----7
On-Cost Overheads Control -----8
Daywork Sheets -----9
Claims -----10
Variation Orders -----11
Preparing Reports -----12
Feedback Comments -----13
Exit -----14

Which do you want ? 5

FIGURE (J-1); SYSTEM ENTRY - FOR MATERIAL CONTROL SELECTION

MATERIAL CONTROL OPTIONS:-

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option ? 1

Supplier No. ? 1

New Supplier ? -Y/N Y

Supplier Name ? CONSTRUCTION EQUIPMENT & TOOLS LTD.

Address ?
151 GRANBY ROAD
LEICESTER
LEICESTERSHIRE
LE11 0TD

Phone No. ? 0533- 587321

Contract ? BALFOUR BEATTY CONSDTRUCTION COSD"

SUPPLIER NO. 1 : CONSTRUCTION EQUIPMENT & TOOLS LTD.

ADDRESS: 151 GRANBY ROAD
LEICESTER
LEICESTERSHIRE

TELEPHONE NO. : 0533- 587321

CONTRACT : BALFOUR BEATTY CONSDTRUCTION C

AM ----- To amend
FI ----- To file
EX ----- To exit

Command ? FI

Supplier No. (1) Record filed.

Is there any more suppliers ? -Y/N Y

FIGURE (J-2); DATA ENTRY - EDITING MATERIAL SUPPLIERS

```

=====
Edit Suppliers -----1
Edit Orders -----2
Edit Deliveries -----3
Determine Fixed Materials ----4
Margins on Deliveries -----5
Margins on Order -----6
View Materials Summary -----7
View Orders Summary -----8
View Suppliers Accounts -----9
Material Utilization report --10
Material Wastage report -----11
Exit -----12

Option ? 2

Order No. ? 1

Is it a new order ? -Y/N Y

Order Registration No. ? 15430P

Supplier No. ? 1

Date of Order ? 24/2/88

Date of due delivery ? 25/2/88

Discount on the purchasing price (%) ? 0

Resource No. ? 151

Resource Quantity ? 300

Resource Unit Price ? 5272.75

Is there any more resources in this order ? -Y/N Y

Resource No. ? 52

Resource Quantity ? 550

Resource Unit Price ? 2.86

Is there any more resources in this order ? -Y/N Y

Resource No. ? 53

Resource Quantity ? 450

Resource Unit Price ? 19.25

Is there any more resources in this order ? -Y/N N

=====
ORDER NO. : 1
-----
REGISTRATION NO. : 15430P
-----
DATE OF ORDER : 24/2/88
-----
DELIVERY DATE : 25/2/88
-----
SUPPLIER NO. : 1: CONSTRUCTION EQUIPMENT & TOOLS
-----
DISCOUNT RATE : 0.00%
=====
NO. DESCRIPTION QUANTITY UNIT UNIT PRICE
---
-----
151 SAND 300.00 M3 2.75
52 SILT 550.00 M3 2.86
53 CEMENT 450.00 M3 19.25
-----
=====

AM ----- To amend
FI ----- To file
EX ----- To exit

Command ? FI

```

FIGURE (J-3); DATA ENTRY - EDITING MATERIAL ORDERS

MATERIAL CONTROL OPTIONS:-

=====

Editing Suppliers -----1
Edit Orders -----2
Edit Deliveries -----3
Determine Fixed Materials ---4
Margins on Deliveries -----5
Margins on Order -----6
View Materials Summary -----7
View Orders Summary -----8
View Suppliers Accounts -----9
Material Utilization report -10
Material Wastage report -----11
Exit -----12

Option ? 3

Order No. ? 1

Date of Last Delivery ? 20/2/88

Resource No. ? 151

Quantity of this delivery ? 300

Delivery Note No. ? 65P

DATE : 20/2/88

PURCHASE ORDER NO. 1 : 15430P

=====

SUPPLIER : CONSTRUCTION EQUIPMENT & TOOLS

RESOURCE NO. 151 : SAND

ORDERED QUANTITY : 300.00 M3

DELIVERED QUANTITY TO DATE : 0.00 M3

THIS DELIVERY : 300.00 M3

DELIVERY NOTE : 65P

AM -----To amend

FI -----To file

EX -----To exit

Option ? FI

Delivery Record filed !

Is there any more deliveries ? -Y/N Y

FIGURE (J-4); DATA ENTRY - EDITING MATERIAL DELIVERIES

DETERMINE FIXED MATERIAL OPTIONS:

- Editing To-Date Material Usage ----- 1
- View Weekly To-Date Material Usage ----- 2
- View Monthly To-Date Material Usage ----- 3
- Exit to the previous menu. ----- 4

The Selection ? 1

WEEK NO. ? 1

Week Ending Date (dd/mm/yy) ? 2/2/88

Material Resource No. ? 151

Cost Center/Activity Code No. ? 3

Measured Quantity for Valuation(Quantity Used to date) ? 50

Unfixed Quantity on Site ? 30

Quantity in Stock ? 200

Other used of material(for temporary works..etc.) ? 10

Is There any more Material Resources ?-Y/N Y

Material Resource No. ? 52

Cost Center/Activity Code No. ? 1

Measured Quantity for Valuation(Quantity Used to date) ? 50

Unfixed Quantity on Site ? 20

Quantity in Stock ? 440

Other used of material(for temporary works..etc.) ? 20

Is There any more Material Resources ?-Y/N Y

Material Resource No. ? 53

Cost Center/Activity Code No. ? 2

Measured Quantity for Valuation(Quantity Used to date) ? 3

Unfixed Quantity on Site ? 20

Quantity in Stock ? 422

Other used of material(for temporary works..etc.) ? 0

Is There any more Material Resources ?-Y/N N

Weekly Used Material Report

WEEK NO.: 1
WEEK ENDING: 2/2/88

RES. NO	ACT. NO	MT VAL.	MT UNFX.	MT STOCK	MT OTHER
151	3	50.00	30.00	200.00	10.00
52	1	50.00	20.00	440.00	20.00
53	2	3.00	20.00	422.00	0.00

- Alt ----- To amend
- F1 ----- To file
- F2 ----- To exit to previous menu.

Continue to report ? Y

FIGURE (J-5); DATA ENTRY - EDITING TO-DATE MATERIAL FIXED DATA

AMENDMENT OPTIONS:

=====

- Week No. ----- 1
- Week Ending Date ----- 2
- Resource No. ----- 3
- Activity/Cost Center No. ----- 4
- Measured Quantity For Val ----- 5
- Unfixed Quantity ----- 6
- Quantity in Stoke ----- 7
- Other Uses of Material ----- 8

Option ? R

Of which resource no. ? 151

Corrected Quantity for Other Uses ? 10

Weekly Used Material Report

=====

WEEK NO.: 1
WEEK ENDING: 2/2/88

RES. NO	ACT. NO	MT VAL.	MT UNFX.	MT STOKE	MT OTHER
151	3	50.00	30.00	200.00	10.00
52	1	50.00	20.00	440.00	20.00
53	2	3.00	20.00	427.00	0.00

- AM ----- To amend
- FI ----- To file
- EX ----- To exit to previous menu.

Which one do you want ? FI

Material Usage Data of week no.(1) filed....

FIGURE (J-6); DATA MAINTENANCE - TODATE
MATERIAL USAGE DATA

DETERMINE FIXED MATERIAL OPTIONS:
=====

- Editing To-Date Material Usage -----
- View Weekly To-Date Material Usage ---
- View Monthly To-Date Material Usage --
- Exit to the previous menu. -----

The Selection ? 2

Required Week No. ? 1

WEEKLY TODATE MATERIAL USAGE-VIEW REPORT

WEEK NO.	1	WEEK ENDING: 2/2/88
RES. NO	DESCRIPTION	UNIT ACT. NO MT. USED
151	SAND	M3 3 68.00
52	SILT	M3 1 76.00
53	CEMENT	M3 2 3.00

Press <CR>, to go back to the menu.

FIGURE (J-7); VIEW REPORT - WEEKLY TO-DATE MATERIAL USAGE

DETERMINE FIXED MATERIAL OPTIONS:
 =====

- Editing To-Date Material Usage ----- 1
- View Weekly To-Date Material Usage ----- 2
- View Monthly To-Date Material Usage ----- 3
- Exit to the previous menu. ----- 4

The Selection 3

Required Month Date(mm/yy) 2/88

TODATE MONTHLY MATERIAL USAGE-VIEW REPORT

RES. NO:	DESCRIPTION	UNIT	ACT. NO	MT. USED
52	SILT	M3	1	100.00
58	MILD STEEL 10MM DIA.	M3	1	1.00
54	MILD STEEL 12MM DIA:	M3	6	-9.00
55	MILD STEEL 16MM DIA.	M3	6	0.60
151	SAND	M3	3	110.00

FIGURE (J-8); VIEW REPORT - MONTHLY TO-DATE MATERIAL USAGE.

Edit Suppliers	1
Edit Orders	2
Edit Deliveries	3
Determine Fixed Materials	4
Margins on Deliveries	5
Margins on Order	6
View Materials Summary	7
View Orders Summary	8
View Suppliers Accounts	9
Material Utilization report	10
Material Wastage report	11
Exit	12

Option ? 5

Today Date (dd/mm/yy) ? 7/3/88

Resource No. ? 151

Any more resource ? -Y/N Y

Resource No. ? 54

Any more resource ? -Y/N Y

Resource No. ? 53

Any more resource ? -Y/N Y

Resource No. ? 57

Any more resource ? -Y/N N

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM DATE: 7/3/88

MARGINS ON DELIVERIES-VIEW REPORT

ESTIMATE				DELIVERED			CREDIT	DEBIT
NO.	UNIT	QT.	RATE	SUM	QT.	RATE		
151	SAND							
	M3	300.00	2.75	825.00	300.00	2.70	810.00	15.00
54	MILD STEEL 12MM DIA.							
	M3	90.00	334.25	30082.50	90.00	334.20	30070.00	4.50
53	CEMENT							
	M3	450.00	19.25	8662.50	450.00	19.20	8640.00	22.50
57	MILD STEEL 25MM DIA.							
	M3	180.00	215.75	38835.00	180.00	215.70	38826.00	9.00
							51.00	0.00
							0.00	
OVERALL MARGINS							51.00	

Press (CR) to go back to the previous menu

FIGURE (J-9); VIEW REPORT - MARGINS ON MATERIAL DELIVERIES

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option ? 6

Today Date (dd/mm/yy) ? 3/3/88

Resource No. ? 151

Any more resource ? -Y/N Y

Resource No. ? 54

Any more resource ? -Y/N Y

Resource No. ? 53

Any more resource ? -Y/N Y

Resource No. ? 58

Any more resource ? -Y/N N

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM DATE: 3/3/88

MARGINS ON MATERIAL ORDERS-VIEW REPORT

ESTIMATE ORDERED

NO.	QUANTITY	UNIT	RATE	SUM	RATE	SUM	CREDIT	DEBIT
151	SAND							
	300.00	M3	2.75	825.00	2.70	810.00	15.00	
54	MILD STEEL 12MM DIA.							
	90.00	M3	334.25	30082.50	334.20	30078.00	4.50	
53	CEMENT							
	450.00	M3	19.25	8662.50	19.20	8640.00	22.50	
58	MILD STEEL 10MM DIA.							
	170.00	M3	206.78	35152.59	206.70	35139.00	13.59	
							55.59	0.00
							0.00	
							55.59	

Press <CR> to return to previous menu:

FIGURE (J-10); VIEW REPORT - MARGINES OF MATERIALS ON ORDERS

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option ? 7

Today Date (dd/mm/yy) ? 7/3/98

Material view-report in progress .

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM

DATE: 7/3/98

MATERIALS SUMMARY-VIEW REPORT

=====

RES. NO.	UNIT	ESTIMATE QUANTITY	ORDERED QUANTITY	DELIVERED QUANTITY	REQUIRED QUANTITY
50	BRICKS				
	NR	170.00	170.00	170.00	0.00
51	SAND				
	M3	300.00	300.00	300.00	0.00
52	SILT				
	M3	550.00	550.00	550.00	0.00
53	CEMENT				
	M3	450.00	450.00	450.00	0.00
54	MILD STEEL 12MM DIA.				
	M3	90.00	90.00	90.00	0.00
55	MILD STEEL 16MM DIA.				
	M3	150.00	150.00	150.00	0.00
56	MILD STEEL 20MM DIA.				
	M3	200.00	200.00	200.00	0.00
57	MILD STEEL 25MM DIA.				
	M3	180.00	180.00	180.00	0.00
58	MILD STEEL 10MM DIA.				
	M3	170.00	170.00	170.00	0.00

Press <CR> to go to the previous menu.

FIGURE (J-11); VIEW REPORT - SUMMARY OF MATERIAL IN USE

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option * 9

View-report in progress

Today Date (dd/mm/yy) * 7/3/88

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM

DATE: 7/3/88

SUPPLIER ACCOUNTS SUMMARY-VIEW REPORT

SUPPLIER NO.	SUPPLIER PHONE NO.	ORDERS ACCOUNT	DELIVERIES ACCOUNT	ACCOUNT DUE
1	CONSTRUCTION EQUIPMENT & TOOLS LTD. 0533- 587321	11060.50	11060.50	0.00
2	EAST MIDLAND MATERIALS 0532- 65419	195320.56	195320.56	0.00

Press (CR) to go back to previous menu.

FIGURE (J-13) VIEW REPORT - SUMMARY OF SUPPLIER ACCOUNTS

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option ? 10

Up to which week no. the report required ? 4

The Estimator Utilization Allowance of Resource No. (52) ? 12.54

The Estimator Utilization Allowance of Resource No. (58) ? 14.28

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM

WEEK NO.: 4

DATE UP TO: 23/2/88

MATERIAL UTILIZATION ON SITE-VIEW REPORT

RES NO.	COST	DILV. CODE	QUANTITY IN STOCK	QUANTITY MEASURED	UTIL. ALLOW (%)	QUANTITY-UNIT/M	COST-POUND/M	LOSSES	GAINS	LOSSES	GAINS
52											
1	550.00		420.00	10.00	13.00	12.54	0.46	0.00	1.32	0.00	
58											
1	170.00		164.00	1.00	6.00	14.28	0.00	6.28	0.00	1212.14	

Press <CR>, to go back to the previous menu.

FIGURE (J-14); VIEW REPORT - WEEKLY MATERILA UTILIZATION ON SITE

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Defaults-----2
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option ? 11

Up to Which week no. the report required ? 1

The Estimator Wastage Allowance(%) of Resource No. (151) ? 2.50

The Estimator Wastage Allowance(%) of Resource No. (52) ? 10.75

The Estimator Wastage Allowance(%) of Resource No. (53) ? 15.00

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM DATE UP TO: 2/2/88

MATERIAL WASTAGE ON SITE-VIEW REPORT

RSE. NO.	COST CODE	UNIT	DELIVRED QUANTITY	MEASURED QUANTITY	UNFIXED QUANTITY	OTHER USES	MATERIAL WAST.(%)	ESTIMATOR ALLOW (%)	REMARKS
151	SAND	3 M3	300.00	50.00	30.00	10.00	3.33	2.50	ABOVE
52	SILT	1 M3	550.00	50.00	20.00	20.00	3.64	10.75	BELOW
53	CEMENT	2 M3	450.00	3.00	20.00	0.00	0.00	15.00	BELOW

Press <CR>, to go back to the menu.

FIGURE (J-15); VIEW REPORT - TO DATE MATERIAL WASTAGE ON SITE

MATERIAL CONTROL OPTIONS:-

=====

- Editing Suppliers -----1
- Edit Orders -----2
- Edit Deliveries -----3
- Determine Fixed Materials ---4
- Margins on Deliveries -----5
- Margins on Order -----6
- View Materials Summary -----7
- View Orders Summary -----8
- View Suppliers Accounts -----9
- Material Utilization report -10
- Material Wastage report -----11
- Exit -----12

Option * 12

*****< Main Menu >*****

Options:-

- Data Preparation -----1
- Bonusing Indices Data -----2
- Labour Control -----3
- Plant Control -----4
- Material Control -----5
- Subcontractors Control -----6
- Preliminaries Control -----7
- On-Cost Overheads Control -----8
- Baywork Sheets -----9
- Claims -----10
- Variation Orders -----11
- Preparing Reports -----12
- Feedback Comments -----13
- Exit -----14

Which do you want * 1

FIGURE (J-16); OPTION SELECTION - UNFIXED MATERIAL DATA

Data Preparation Options:-

- ```

=====
Bill Items Data -----1
BOQ Valuation Data -----2
Resources Data -----3
Sub-Contractors Data -----4
Cost Center Data -----5
Sections Data -----6
Unfixed Material Data-----7
Engineer's Assessment for Price Adjustment ---8
Exit -----9

```

Which do you want ? 7

Valuation No. ? 1

Material Resource No. ? 54

Quantities of Resource ? 0.5

Percentage to be paid for ? 70.75

Cost Center ? A

Section ? 1

Is there any more unfixed materials-----Y/N ? Y

Material Resource No. ? 52

Quantities of Resource ? 20

Percentage to be paid for ? 80.5

Cost Center ? 1

Section ? 1

Is there any more unfixed materials-----Y/N ? N

VALUATION NO. 1 UNFIXED MATERIALS

```

=====
MAT NO. DESCRIPTION QUANTITY UNIT RATE PROP

 54 MILD STEEL 12MM DIA. 0.50 M3 334.25 70.7
 52 SILT 20.00 M3 2.86 80.5

```

\*\*END OF UNFIXED MATERIALS\*\*

MD -----To amend  
 FI -----To file  
 EX -----To exit

Option ? FI

Unfixed Materials filed ...!

FIGURE (J-17); DATA ENTRY - UNFIXED MATERIAL ON SITE DATA

## APPENDIX (K)

FIGURES (1-16); SHOW THE DATA ENTRY OF "SUB-  
CONTRACTOR CONTROL ON SITE"  
FUNCTION WITH ITS ON-SCREEN  
REPORTS. THE UNDERLINED TEXT  
ARE SAMPLES OF THE USRER INPUTS

To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ----3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 MANSFIELD ROAD  
DERBY  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY,  
DERBYSHIRE,  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

+++++< Main Menu >+++++

Options:-

Data Preparation -----1  
Bonusing Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 6

FIGURE (K-1); SYSTEM ENTRY - "SUBCONTRACTOR CONTROL" ON SITE FUNCTION

SUB-CONTRACTORS CONTROL OPTIONS:-

=====

- Editing Weekly Payment Sheets ----- 1
- Editing Monthly Liability Summary ----- 2
- Claims Registration and Measurement ---- 3
- Variation Orders Calculations ----- 4
- View Weekly Letting Margins ----- 5
- View Monthly Liability Summary ----- 6
- View Monthly Accounting Reports ----- 7
- Exit ----- 8

Which one do you want ? 1

WEEK NO. ? 1

WEEK ENDING DATE (dd/mm/yy) ? 2/2/88

Sub-Contractor No. ? 1

Related Cost Center Code No. ? 1

This Week Payment ? 250.75

Quantity Executed (as units) ? 1

Is there any more sub-contractors ?Y/N Y

Sub-Contractor No. ? 2

Related Cost Center Code No. ? 4

This Week Payment ? 601.25

Quantity Executed (as units) ? 20

Is there any more sub-contractors ?Y/N Y

Sub-Contractor No. ? 3

Related Cost Center Code No. ? 224F

This Week Payment ? 210.00

Quantity Executed (as units) ? 90

Is there any more sub-contractors ?Y/N N

WEEK NO.: 1                      WEEK ENDING:2/2/88

| S/C NO. | ACTIVITY NO. | PAYMENT | QT. EXEC |
|---------|--------------|---------|----------|
| 1       | 1            | 250.75  | 1.00     |
| 2       | 4            | 601.25  | 20.00    |
| 3       | 224          | 210.00  | 90.00    |

- AM ----- To amend
- FI ----- To file
- FX ----- To exit

Which do you want ? AM

FIGURE (K-2); DATA ENTRY - WEEKLY SUBCONTRACTOR PAYMENT SHEET DATA

AMENDMENT OPTIONS:

=====

Week No. ----- 1  
Week Ending Date ----- 2  
Subcontractor's No. ----- 3  
Related Activity Code No. ----- 4  
This Week Payment ----- 5  
Quantity Executed ----- 6

Which option ? 4

For which sub-contractor" no. ? 3

Corrected Related Activity Code ? 9

WEEK NO.: 1

WEEK ENDING: 2/2/88

| S/C NO. | ACTIVITY NO. | PAYMENT | QT. EXEC |
|---------|--------------|---------|----------|
| 1       | 1            | 250.75  | 1.00     |
| 2       | 4            | 601.25  | 20.00    |
| 3       | 9            | 210.00  | 90.00    |

AM ----- To amend

FI ----- To file

FX ----- To exit

Which do you want ? FI

Sub-Contractors Payment Sheet of Week No. ( 1 ) filed.....

FIGURE (K-3); DATA MAINTENANCE - WEEKLY PAYMENT SHEET

SUB-CONTRACTORS CONTROL OPTIONS:-

- Editing Weekly Payment Sheets ----- 1
- Editing Monthly Liability Summary ----- 2
- Claims Registration and Measurement ---- 3
- Variation Orders Calculations ----- 4
- View Weekly Letting Margins ----- 5
- View Monthly Liability Summary ----- 6
- View Monthly Accounting Reports ----- 7
- Exit ----- 8

Which one do you want ? 2

Monthly Summary Sheet No. ? 1

Summary Month Date (MM/YY) ? 2/88

Sub-Contractor No. ? 1

Related Cost Center Code ? 1

Money Paid ? 963.05

Total Retention ? 96.3

Money Paid for claims ? 0

Money Paid for Variation Orders ? 0

Work Executed This Month (as units) ? 4

Is there any more sub-contractors ?-Y/N Y

Sub-Contractor No. ? 2

Related Cost Center Code ? 4

Money Paid ? 2392.25

Total Retention ? 239.22

Money Paid for claims ? 135.50

Money Paid for Variation Orders ? 126.85

Work Executed This Month (as units) ? 50

SHEET NO.: 1

WEEK ENDING: 2/88

| S/C NO. | ACTIVITY NO. | MONEY PAID | RETENT. TOTAL | CLAIMS MONEY | U/O MONEY | QT. EXEC |
|---------|--------------|------------|---------------|--------------|-----------|----------|
| 1       | 1            | 963.05     | 96.30         | 0.00         | 0.00      | 4.00     |
| 2       | 4            | 2392.25    | 239.22        | 135.50       | 126.85    | 50.00    |
| 3       | 9            | 1002.00    | 100.20        | 0.00         | 0.00      | 130.00   |

AK ----- To amend  
 FI ----- To file  
 FF ----- To exit

FIGURE (K-4); DATA ENTRY - MONTHLY LIABILITY SUMMARY DATA



AMENDMENT OPTIONS:

-----  
 Sheet No. -----1  
 Month Date -----2  
 Sub-Contractor's No. -----3  
 Related Activity Code -----4  
 Money Paid -----5  
 Total Retention -----6  
 Money for Claims -----7  
 Money for Variation Orders -----8  
 Work Executed -----9

Required Amendment ? 9

For which sub-contractor's no. ? 1

Connected Work Executed (as units) ? 5

SHEET NO.: 1

WEEK ENDING: 2/85

| S/C NO. | ACTIVITY NO. | MONEY PAID | RETENT. TOTAL | CLAIMS MONEY | V/O MONEY | RT. EXEC |
|---------|--------------|------------|---------------|--------------|-----------|----------|
| 1       | 1            | 963.05     | 96.30         | 0.00         | 0.00      | 5.00     |
| 2       | 4            | 2392.25    | 239.22        | 135.50       | 126.85    | 50.00    |
| 3       | 9            | 1002.00    | 100.20        | 0.00         | 0.00      | 130.00   |

-----  
 AI ----- To amend  
 FI ----- To file  
 EX ----- To exit

Which one do you want ? FI

FIGURE (K-5); DATA MAINTENANCE - MONTHLY LIABILITY SYMMARY DATA

SUB-CONTRACTORS CONTROL OPTIONS:-

- 
- Editing Weekly Payment Sheets ----- 1
- Editing Monthly Liability Summary ----- 2
- Claims Registration and Measurement ----- 3
- Variation Orders Calculations ----- 4
- View Weekly Letting Margins ----- 5
- View Monthly Liability Summary ----- 6
- View Monthly Accounting Reports ----- 7
- Exit ----- 8

Which one do you want ? 3

CLAIM OPTIONS:-

- 
- Registration Claims ----- 1
- Measurement Claims ----- 2
- Exit ----- 3

Which option do you want ? 1

CLAIM REGISTRATION OPTIONS:-

- 
- Editing Claim Registration ----- 1
- View Claim Summary ----- 2
- Exit ----- 3

OPTION ? 1

Claim No. ? 1

New Claim ?-Y/N

Claim Description ? UNFORESEEN GROUND CONDITION

Date of Claim ? 12/2/88

Subject to Price Fluctuation ?-Y/N N

Is it accepted ?-Y/N Y

The related letters/documents:-<CR> when finished:

- 1-Y/N/8
- 2-UYN/9
- 3-

CLAIM NO. : 1  
DESCRIPTION : UNFORESEEN GROUND CONDITION  
CLAIM DATE : 12/2/88  
SUBJECT TO ADJUSTMENT : N  
CLAIM ACCEPTANCE : Y  
RELATED DOCUMENTS: Y/N/8  
UYN/9

Is there any amendments ? -Y/N N

Claim No. ( 1 ) registered

FIGURE (K-6); DATA ENTRY - SUBCONTRACTOR CLAIM DATA

CLAIM REGISTRATION OPTIONS:-  
=====

- Editing Claim Registration ----- 1
- View Claim Summary ----- 2
- Exit ----- 3

OPTION ? 2

CLAIMS SUMMARY-VIEW REPORT  
=====

| CLAIM NO. | DESCRIPTION                 | DATE    | ACCEPTED |
|-----------|-----------------------------|---------|----------|
| 1         | UNFORESEEN GROUND CONDITION | 12/2/88 | YES      |
| 2         | CHANGING IN THE DRAWING     | 20/2/88 | NO       |

Press <CR> to go back to previous menu.

FIGURE (K-7); VIEW REPORT - CLAIM SUMMARY REPORT

CLAIM OPTIONS:-

=====

Registration Claims ----- 1  
Measurement Claims ----- 2  
Exit ----- 3

Which option do you want ? 2

CLAIM MEASUREMENT OPTIONS:-

-----

Editing Claim Measurements ----- 1  
View Individual Claim Summary ----- 2  
View Total Claims Summary ----- 3  
Exit ----- 4

Option ? 1

Claim No. ? 2

Valuation No. ? 1

Labour Total Amount ? 50.75

Plant Amount ? 30.85

Material Amount ? 28.35

Preliminaries Amount ? 90.10

CLAIM NO.: 2  
CLAIM DESCRIPTION: CHANGING IN THE DRAWING  
CLAIM DATE: 20/2/88  
VALUATION NO.: 1

| LAB. AMNT | PLA. AMNT | MAT. AMNT | PREL AMNT | TOTAL  |
|-----------|-----------|-----------|-----------|--------|
| 50.75     | 30.85     | 28.35     | 90.10     | 200.05 |

-----

AH ----- To amend  
FI ----- To file  
FI ----- To exit

Option ? FI

Measurement of Claim No. ( 2 filed.....

FIGURE (K-8); DATA ENTRY - CLAIM MEASUREMENTS DATA

CLAIM MEASUREMENT OPTIONS:-

=====

- Editing Claim Measurements -----1
- View Individual Claim Summary -----2
- View Total Claims Summary -----3
- Exit -----4

Option ? 2

Required Claim No. ? 1

VALUATION NO.( 1)

=====

CLAIM NO.: 1  
CLAIM DESCRIPTION: UNFORESEEN GROUND CONDITION  
CLAIM DATE: 12/2/88  
RESOURCE DESCRIPTION      AMOUNT  
-----  
LABOUR                      90.00  
PLANT                        53.00  
MATERIAL                    68.00  
PRELIMINARIES              18.00  
-----  
TOTAL                        221.00

=====

Press <CR> to go back to previous menu

FIGURE (K-9); VIEW REPORT - INDIVIDUAL CLAIM SUMMARY

CLAIM MEASUREMENT OPTIONS:-  
=====

- Editing Claim Measurements -----1
- View Individual Claim Summary -----2
- View Total Claims Summary -----3
- Exit -----4

Option ? 3

For which valuation no. ? 1

VALUATION NO. ( 1 )  
=====

| CL. NO. DESCRIPTION           | LABOUR AMOUNT | PLANT AMOUNT | MATERIAL AMOUNT | PRELIMI. AMOUNT     | TOTAL  |
|-------------------------------|---------------|--------------|-----------------|---------------------|--------|
| 1 UNFORESEEN GROUND CONDITION | 98.98         | 53.88        | 68.00           | 18.00               | 221.00 |
| 2 CHANGING IN THE DRAWINGS    | 50.75         | 30.85        | 28.35           | 90.10               | 200.05 |
|                               |               |              |                 | TOTAL CLAIMS AMOUNT | 421.05 |

Press <CR> to go back to previous menu

FIGURE (K-10); VIEW REPORT - TOTAL CLAIMS SUMMARY

VARIATION OPTION:

=====

Editing Variation Orders ----- 1  
Editing Variation Orders Items ----- 2  
View Variation Orders Summary ----- 3  
Variation Orders Accounts ----- 4  
Exit ----- 5

Option ? 1

Variation Order No. ? 1

Is it a new order ?-Y/N Y

Date of Issue ? 14/2/88

U.O. Description ? CHANGING THE DRAWING TO YHI/1/88

Architect/Engineer Instruction No. ? 76

Related Reference Code ? YUI/88

VARIATION ORDER NO.: 1

=====

DESCRIPTION : CHANGING THE DRAWING TO YHI/1/88

=====

DATE OF ISSUE: 14/2/88

=====

INSTRUCTION NO.: 76

=====

REFERENCE CODE: YUI/88

-----

AI ----- To amend

FI ----- To file

EI ----- To exit

FI

Variation Order No. ( 1 ) filed.

FIGURE (K-11); DATA ENTRY - SUBCONTRACTOR VARIATION ORDER GENERAL DATA

```

CAPABILITY MENU
.....
Editing Variation Orders 1
Editing Variation Orders Items 2
View Variation Orders Summary 3
Variation Orders Accounts 4
Exit 5

Option ? 2
Variation Order No. ? 2
Item Code ? 223B
Variation Order Page No. ? 1
Variation Order Item No. ? 1

BOG ITEM CODE : 223B

ATTENSTONED SINGLE SIDED CORRUGATED
BEAM

U.O. Item No. ----- 1
Variation Order Page ----- 1
Item Unit ----- H
Item Old Rate ----- 7.10
Item New Rate ----- 7.10
Item Old Quantity ----- 740.00
Item New Quantity ----- 740.00

VARIATION REQUIREMENTS :

Amend Item Quantity ----- 1
Amend Item Rate ----- 2
Exit ----- 3
<CR> -- to continue

Which one to amend ? 1

TYPES OF AMENDMENTS:

Add to BOG Figures ----- 1
Subtract from BOG Figures ----- 2
Replace BOG Figures ----- 3
Exit ----- 4

Amendment ? 2
Subtracted Quantity ? 10

BOG ITEM CODE : 223B

ATTENSTONED SINGLE SIDED CORRUGATED
BEAM

U.O. Item No. ----- 1
Variation Order Page ----- 1
Item Unit ----- H
Item Old Rate ----- 7.10
Item New Rate ----- 7.10
Item Old Quantity ----- 740.00
Item New Quantity ----- 730.00

VARIATION REQUIREMENTS :

Amend Item Quantity ----- 1
Amend Item Rate ----- 2
Exit ----- 3
<CR> -- to continue

Which one to amend ?

Is there any more items included ?-Y/N N
Do you want to file the V.O. ?-Y/N Y
Variation Order No. (2) filed.

```

FIGURE (K-12); DATA ENTRY - SUBCONTRACTOR VARIATION ORDER ITEMS MEASUREMENT DATA



VARIATION OPTION:

=====

- 1 Editing Variation Orders -----
- 2 Editing Variation Orders Items -----
- 3 View Variation Orders Summary -----
- 4 Variation Orders Accounts -----
- 5 Exit -----

Option ? 3

VARIATION ORDERS SUMMARY-VIEW REPORT

=====

| V.O. NO. | V.O. DESCRIPTION                                      | DATE    | INS. NO. | REF. CODE |
|----------|-------------------------------------------------------|---------|----------|-----------|
| 1        | CHANGING THE DRAWING TO 7H1/1/68                      | 14/2/68 | 76       | YJ1/68    |
| 2        | INCREASE IN REMOVED MATERIAL REFUSE<br>OF WATER LEVEL | 25/2/88 | 690      | YJ1./988  |

=====

Press <CR> to go back to previous main.

FIGURE (K-13); VIEW REPORT - SUBCONTRACTOR VARIATION  
ORDERS SUMMARY

VARIATION OPTION:

\*\*\*\*\*

Editing Variation Orders ----- 1  
Editing Variation Orders Items ----- 2  
View Variation Orders Summary ----- 3  
Variation Orders Accounts ----- 4  
Exit ----- 5

Option ? 4

Required Variation Order No. ? 1

U.O. NO. 2 ; CHNGING IN THE DRAWING TO YHI/2/88  
DATE OF ISSUE :14/2/88

SUMMARY OF VARIATIONS

\*\*\*\*\*

| ITEM NO. | NATURE OF WORK                                         | UNIT | OMISSIONS                 | ADDITIONS |
|----------|--------------------------------------------------------|------|---------------------------|-----------|
| 1        | 2REMOVAL OF EXISTING SEWER OF<br>DRAINS 150MM DIAMETER | M    | 475.00                    |           |
| 2        | 7UNTENSIONED SINGLE SIDED OPEN<br>BOX BEAM             | M    | 4280.00                   |           |
| 3        | 9CONCRETE GROUND BEAM WITH SOCKETS<br>AT 1.2M CENTRES  | M    | 101.00                    |           |
|          |                                                        |      | -----                     | -----     |
|          |                                                        |      | 4856.00                   | 0.00      |
|          |                                                        |      | 0.00                      |           |
|          |                                                        |      | -----                     | -----     |
|          |                                                        |      | NET VARIATION ORDER TOTAL | 4856.00   |

-----  
Press <CR> to go back to previous menu.

FIGURE (K-14); VIEW REPORT - SUMMARY OF SUBCONTRACTOR  
VARIATION ORDER MEASUREMENT ITEMS DATA

SUB-CONTRACTORS CONTROL OPTIONS:-

=====

- Editing Weekly Payment Sheets ----- 1
- Editing Monthly Liability Summary ----- 2
- Claims Registration and Measurement ---- 3
- Variation Orders Calculations ----- 4
- View Weekly Letting Margins ----- 5
- View Monthly Liability Summary ----- 6
- View Monthly Accounting Reports ----- 7
- Exit ----- 8

Which one do you want ? 5

Required Week No. ? 1

WEEKLY SUBCONTRACTORS LETTING MARGINS-VIEW REPORT

-----

WEEK NO.: 1

WEEK ENDING: 2/2/88

| S/C NO. | NAME           | VALUE  | PAYMENT | VARIANCE | REMARK |
|---------|----------------|--------|---------|----------|--------|
| 1       | RIGER N, SMITH | 250.75 | 250.75  | 0.00     | GAIN   |
| 2       | GEORGE WHITE   | 650.00 | 601.25  | 48.75    | GAIN   |
| 3       | R.E. DOGLUS    | 238.50 | 210.00  | 28.50    | GAIN   |

Press <CR> to go back to previous menu

FIGURE (K-15); VIEW REPORT - WEEKLY LETTING MARGINS

SUB-CONTRACTORS CONTROL OPTIONS:-

=====

- Editing Weekly Payment Sheets ----- 1
- Editing Monthly Liability Summary ----- 2
- Claims Registration and Measurement ---- 3
- Variation Orders Calculations ----- 4
- View Weekly Letting Margins ----- 5
- View Monthly Liability Summary ----- 6
- View Monthly Accounting Reports ----- 7
- Exit ----- 8

Which one do you want ? 6

Required Month Date (mm/yy) ? 2/88

MONTHLY SUB-CONTRACTORS LIABILITY SUMMARY-VIEW REPORT

=====

SHEET NO.: 1

MONTH DATE: 2/88

| S/C<br>NO. NAME  | VALUE<br>OF WORK | CERT.<br>LIAB. | TOTAL<br>LIAB. | CLAIMS<br>LIAB. | V/O<br>LIAB. | TOTAL   |
|------------------|------------------|----------------|----------------|-----------------|--------------|---------|
| 1 RIGER W, SMITH | 1003.00          | 963.05         | 96.30          | 0.00            | 0.00         | 866.75  |
| 2 GEORGE WHITE   | 1625.00          | 2392.25        | 239.22         | 135.50          | 126.85       | 2415.38 |
| 3 R.E. DOGLUS    | 344.50           | 1002.00        | 100.20         | 0.00            | 0.00         | 701.80  |

Press <CR> to go back to previous menu

FIGURE (K-16); VIEW REPORT - MONTHLY SUBCONTRACTOR LIABILITY SUMMARY

## APPENDIX (L)

FIGURES (1-11); THE DATA ENTRY OF "PRELIMINARY CONTROL ON SITE" FUNCTION FOR BOTH TYPES OF PRELIMINARIES (BILL ITEMS AND IN RATES) WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF THE USER INPUTS.

To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ---3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 MANSFIELD ROAD  
DERBY  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY.  
DERBYSHIRE.  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

=====

Press (CR) to go into the system.

\*\*\*\*\*< Main Menu >\*\*\*\*\*

Options:-

-----  
Data Preparation -----1  
Bonusing Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 2

FIGURE (L-1); SYSTEM ENTRY - PRELIMINARY CONTROL SELECTION

FIGURE (2-7); DATA ENTRY OF "PRELIMINARY  
CONTROL" FUNCTION WITH ITS  
ON-SCREEN REPORTS.

PRELIMINARIES CONTROL OPTIONS:-

\*\*\*\*\*

- 000 Preliminary Items ----- 1
- Preliminaries in Rates ----- 2
- Exit ----- 3

Which one to select ? 1

Preliminary Items Options:-

\*\*\*\*\*

- Editing Preliminary Resources Data ----- 1
- Editing Preliminary Resources Site Data ----- 2
- View Preliminary Resources Summary ----- 3
- View Preliminary Calculation Weekly Report -- 4
- View Preliminary Calculation Monthly Report - 5
- Exit ----- 6

Option ? 1

Preliminary Code No. ? 01

Preliminary Description (up to 40 letters) ? SUPER VISION

Preliminary Bill Total ? 4385.85

Preliminary Valuation Type:-

-----

- Time Related ----- 1
- Cost Related ----- 2
- Lump Sum ----- 3

Type ? 1

Initial Lump Sum ? 510.00

Recurring Sum ? 251.75

Recurring Period (Weeks) ? 1

PRELIMINARY CODE NO.: 01

PRELIMINARY DESCRIPTION: SUPER VISION

VALUATION TYPE : TIME RELATED

INITIAL LUMP SUM: 510.00

RECURRING SUM: 251.75

RECURRING PERIOD: 1

\*\*\*\*\*

00 ----- To print

01 ----- To file

02 ----- To send to the operator

FIGURE (L-2); DATA ENTRY - EDITING PRELIMINARY RESOURCE DATA



Preliminary Code No. ----- 1  
Preliminary Description ----- 2  
Valuation Type ----- 3  
Preliminary Bill Sum ----- 4  
Initial Lump Sum ----- 5  
Recurring Sum ----- 6  
Recurring Period ----- 7

Which one to amend ? 2

Corrected Preliminary Description ? SUPERVISION

PRELIMINARY CODE NO.: 81  
-----

PRELIMINARY DESCRIPTION: SUPERVISION  
-----

VALUATION TYPE : TIME RELATED  
-----

INITIAL LUMP SUM: 518.00  
-----

RECURRING SUM: 251.75  
-----

RECURRING PERIOD: 1  
-----

=====

|    |       |                              |
|----|-------|------------------------------|
| AM | ----- | To amend                     |
| FI | ----- | To file                      |
| FX | ----- | To exit to the previous menu |

Option ? FI

Preliminary No. ( 81) data filed .

FIGURE (L-3); DATA MAINTENANCE - PRELIMINARY RESOURCE DATA

Editing Preliminary Resources Data ----- 1  
 Editing Preliminary Resources Site Data ----- 2  
 View Preliminary Resources Summary ----- 3  
 View Preliminary Calculation Weekly Report -- 4  
 View Preliminary Calculation Monthly Report - 5  
 Exit ----- 6

Station ? 2  
 Leak No. ? 1  
 Leak Ending Date (Day/Month/Year, ++/++/++) ? 2/2/88  
 Sheet No. ? 1  
 Preliminary Code No. ? R1

Preliminary Cost Fractions:-

-----  
 Bonus Cost ? 53.85  
 Labour Cost ? 52.50  
 Plant Cost ? 80.75  
 Total Cost: 187.10

Are more preliminaries ?-Y/M Y

Preliminary Code No. ? R5

Preliminary Cost Fractions:-

-----  
 Bonus Cost ? 20.86  
 Labour Cost ? 180.35  
 Plant Cost ? 50.75  
 Total Cost: 251.96

Are more preliminaries ?-Y/M Y

Preliminary Code No. ? R5.R5

Preliminary Code No. ? R7

Preliminary Cost Fractions:-

-----  
 Bonus Cost ? 25.85  
 Labour Cost ? 20.00  
 Plant Cost ? 19.75  
 Total Cost: 65.60

Are more preliminaries ?-Y/M N

SHEET NO.: 1 WEEK NO. : 1  
 WEEK DATE: 2/2/88

| PREM. NO. | BONUS COST | LABOUR COST | PLANT COST | TOTAL COST |
|-----------|------------|-------------|------------|------------|
| R1        | 53.85      | 52.50       | 80.75      | 187.10     |
| R5        | 20.86      | 180.35      | 50.75      | 251.96     |
| R7        | 25.85      | 20.00       | 19.75      | 65.60      |

A# ----- To amend  
 F# ----- To file  
 E# ----- To exit to previous menu

Station ? F1  
 Preliminary Site Sheet No. ( 1 ) filed.  
 Are there any more sheets ?-Y/M N

FIGURE (L-4); DATA ENTRY - PRELIMINARY RESOURCE SITE DATA

Preliminary Items Options:-

- 1
- Editing Preliminary Resources Data ----- 1
- Editing Preliminary Resources Site Data ----- 2
- View Preliminary Resources Summary ----- 3
- View Preliminary Calculation Weekly Report -- 4
- View Preliminary Calculation Monthly Report - 5
- Exit ----- 6

Option 3

PRELIMINARY RESOURCES REEPORT-VIEW REPORT

| NO. | DESCRIPTION | VAL. | TYPE      | PR. | BILL | TOTAL   | INIT. | LUMP    | SUM | RECU. | PERIOD |
|-----|-------------|------|-----------|-----|------|---------|-------|---------|-----|-------|--------|
| 81  | SUPERVISION |      |           |     |      |         |       |         |     |       |        |
|     |             |      | Time Rel. |     |      | 4385.85 |       | 510.00  |     |       | 1      |
| 85  | HOISTS      |      |           |     |      |         |       |         |     |       |        |
|     |             |      | Cost Rel. |     |      | 1457.87 |       | 380.75  |     |       | 1      |
| 83  | INSURANCE   |      |           |     |      |         |       |         |     |       |        |
|     |             |      | Lump Sum  |     |      | 1830.75 |       | 1830.76 |     | ***** |        |
| 87  | TOWER CRANE |      |           |     |      |         |       |         |     |       |        |
|     |             |      | Time Rel. |     |      | 2875.75 |       | 115.00  |     |       | 1      |

Press <CR> key to go back to previous menu

FIGURE (L-5); VIEW REPORT - PRELIMINARY RESOURCE SUMMARY

Preliminary Items Options:-

=====

Editing Preliminary Resources Data ----- 1  
Editing Preliminary Resources Site Data ----- 2  
View Preliminary Resources Summary ----- 3  
View Preliminary Calculation Weekly Report -- 4  
View Preliminary Calculation Monthly Report - 5  
Exit ----- 6

Option ? 4

Required Week No. ? 1

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
CONTRACT NO. : 1

WEEK NO. : 1  
WEEK DATE: 2/2/88

PRELIMINARIES WEEKLY CALCULATION REPORT-VIEW REPORT

=====

| NO. | DESCRIPTION | PR. | TENDER TOT | TENDER BUDGET | PRELM. COSTED | REMARKS   |
|-----|-------------|-----|------------|---------------|---------------|-----------|
| 81  | SUPERVISION |     |            |               |               |           |
|     |             |     | 4365.85    | 510.00        | 187.10        | UNDER COV |
| 85  | HOISTS      |     | 1457.87    | *****         | 251.96        | UNKNOWN   |
| 87  | TOWER CRANE |     | 2875.75    | 115.00        | 65.60         | UNDER COV |

Press <CR> to go back to previous menu.

FIGURE (L-6); VIEW REPORT - PRELIMINARY CALCULATION  
WEEKLY REPORT

Preliminary Items Options:-

=====

- Editing Preliminary Resources Data ----- 1
- Editing Preliminary Resources Site Data ----- 2
- View Preliminary Resources Summary ----- 3
- View Preliminary Calculation Weekly Report -- 4
- View Preliminary Calculation Monthly Report - 5
- Exit ----- 6

Option ? 5

Preliminary Resources Monthly View Report in Progress.....

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
CONTRACT NO.: 1

MONTH DATE: 2/88

PRELIMINARIES MONTHLY CALCULATION REPORT-VIEW REPORT

=====

| NO. | DESCRIPTION | PR. | TENDER TOT | TENDER BUDGET | PRELM. COSTED | REMARK    |
|-----|-------------|-----|------------|---------------|---------------|-----------|
| 81  | SUPERVISION |     |            |               |               |           |
|     |             |     | 4385.85    | 1265.25       | 187.10        | UNDER COV |
| 85  | HOISTS      |     |            |               |               |           |
|     |             |     | 1457.87    | 377.79        | 251.96        | UNDER COV |
| 87  | TOWER CRANE |     |            |               |               |           |
|     |             |     | 2875.75    | 372.25        | 65.60         | UNDER COV |

Press <CR> to go back to previous menu

FIGURE (L-7); VIEW REPORT - PRELIMINARY CALCULATION MONTHLY REPORT

FIGURES (8-11); THE DATA ENTRY OF "PRELIMINARY  
IN-RATES CONTROL" FUNCTION WITH  
ITS ON-SCREEN REPORTS

PRELIMINARIES CONTROL OPTIONS:-

=====

- Run Preliminary Items ----- 1
- Preliminaries in Rates ----- 2
- Exit ----- 3

Which one to select ? 2

PRELIMINARIES IN RATES OPTION:

=====

- Editing Weekly Payment Sheets ----- 1
- View Weekly Payment Calculation ----- 2
- View Monthly Payment Calculation ----- 3
- Exit ----- 4

Option ? 1

User No. ? 1

Week Ending Date (dd/mm/yy) ? 2/2/88

Sheet No. ? 1

Preliminary Resource No. ? R1

Preliminary Resource No. (R1) not found, try again please.

Preliminary Resource No. ? 15

Related Cost Center Code ? 1

Activity Dedication (Z) ? 90

Preliminary This Week Cost ? 200.75

Is there any more preliminaries ?-Y/N Y

Preliminary Resource No. ? 15

Related Cost Center Code ? 3

Activity Dedication (Z) ? 40

Preliminary This Week Cost ? 45

Is there any more preliminaries ?-Y/N Y

Preliminary Resource No. ? 15

Related Cost Center Code ? 6

Activity Dedication (Z) ? 20

Preliminary This Week Cost ? 275.85

Is there any more preliminaries ?-Y/N N

WEEK NO.: 1  
 WEEK ENDING: 2/2/88  
 SHEET NO.: 1

| LINE NO | PR. NO. | DESCRIPTION | RL. ACT | DEB.(Z) | WEEK COST |
|---------|---------|-------------|---------|---------|-----------|
| 1       | 15      | TOWER CRANE | 1       | 90.00   | 200.75    |
| 2       | 15      | TOWER CRANE | 3       | 40.00   | 45.00     |
| 3       | 15      | TOWER CRANE | 6       | 20.00   | 275.85    |

AA ----- To amend  
 FF ----- To file  
 EE ----- To exit to the menu.

Which do you want ? AM

FIGURE (L-8); EDITING WEEKLY PAYMENT SHEET

AMENDMENT OPTIONS:

=====

- Week No. ----- 1
- Week Ending Date ----- 2
- Sheet No. ----- 3
- Preliminary Resource No. ----- 4
- Related Activity Code ----- 5
- Dedication Percentage ----- 6
- This Week Cost ----- 7

Which one to amend ? 6

Required Line No. ? 1

Activity Dedication (%) ? 40

WEEK NO.: 1  
 WEEK ENDING: 2/2/88  
 SHEET NO.: 1

| LINE NO | PR. NO. | DESCRIPTION | RL. ACT | DED.(%) | WEEK COST |
|---------|---------|-------------|---------|---------|-----------|
| 1       | 15      | TOWER CRANE | 1       | 40.00   | 200.75    |
| 2       | 15      | TOWER CRANE | 3       | 40.00   | 45.00     |
| 3       | 15      | TOWER CRANE | 6       | 20.00   | 275.85    |

- AM ----- To amend
- FI ----- To file
- FX ----- To exit to the menu.

Which do you want ? FI

Weekly Preliminary Resources Cost of week ( 1 ) filed.....

FIGURE (L-9); DATA MAINTENANCE - PRELIMINARY PAYMENT SHEET DATA



PRELIMINARIES IN RATES OPTION:

=====

Editing Weekly Payment Sheets ----- 1  
 View Weekly Payment Calculation ----- 2  
 View Monthly Payment Calculation ----- 3  
 Exit ----- 4

Option ? 2

Required Week No. ? 1

WEEKLY PRELIMINARY IN RATES CALCULATION-VIEW REPORT

=====

WEEK NO.: 1

WEEK ENDING: 2/2/88

| PR. NO.            | DESCRIPTION | RL. ACT. | DED. (%) | WEEK COST |
|--------------------|-------------|----------|----------|-----------|
| 15                 | TOWER CRANE | 1        | 40.00    | 200.75    |
| 15                 | TOWER CRANE | 3        | 40.00    | 45.00     |
| 15                 | TOWER CRANE | 6        | 20.00    | 275.85    |
| TOTAL OVERALL COST |             |          |          | 521.60    |

=====

Press <CR>, to go back to the menu.

FIGURE (L-10); VIEW REPORT - WEEKLY PAYMENT CALCULATION REPORT

PRELIMINARIES IN RATES OPTION:

=====

Editing Weekly Payment Sheets ----- 1  
View Weekly Payment Calculation ----- 2  
View Monthly Payment Calculation ----- 3  
Exit ----- 4

Option ? 3

Required Month Date (mm/vv) ? 2/88

MONTHLY PRELIMINARY IN-RATES CALCULATION-VIEW REPORT

=====

MONTH DATE: 2/88

| PR. NO. | DESCRIPTION | RL. ACT. | DED. (Z)                | MONTH COST |
|---------|-------------|----------|-------------------------|------------|
| 15      | TOWER CRANE | 6        | 20.00                   | 521.60     |
|         |             |          | OVERALL THIS MONTH COST | 521.60     |

=====  
Press <CR>. to go back to the menu.

FIGURE (L-11); VIEW REPORT - MONTHLY PAYMENT SHEET

## APPENDIX (M)

FIGURES (1-8); SHOW THE DATA ENTRY OF "CLAIM  
REGISTRATION AND MEASUREMSNT ON  
SITE" FUNCTION WITH ITS ON-SCREEN  
REPORTS, AS DIALOGUES BETWEEN THE  
USER AND "PLUS COST". THE UNDERLINED  
TEXT ARE SAMPLES OF THE USER INPUTS

To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ----3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION OPS SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 MANSFIELD ROAD  
DERBY  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY.  
DERBYSHIRE.  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

-----  
Press <CR> to go into the system.

\*\*\*\*\*< Main Menu >\*\*\*\*\*

Options:-  
-----

Data Preparation -----1  
Revising Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 14

FIGURE (M-1); SYSTEM ENTRY - "CLAIM CONTROL"  
FUNCTION

CLAIM OPTIONS:-

=====

Registration Claims ----- 1  
Measurement Claims ----- 2  
Exit ----- 3

Which option do you want ? 1

CLAIM REGISTRATION OPTIONS:-

=====

Editing Claim Registration ----- 1  
View Claim Summary ----- 2  
Exit ----- 3

OPTION ? 1

Claim No. ? 1

New Claim ?-Y/N Y

Claim Description ? UNFORESEEN GROUND CONDITION

Date of Claim ? 23/2/88

Subject to Price Fluctuation ?-Y/N N

Is it accepted ?-Y/N Y

The related letters/documents:-<CR> when finished:

1-ER/2/88

2-EO/2/88

3-EF/2/88

4-

CLAIM NO. : 1  
DESCRIPTION : UNFORESEEN GROUND CONDITION  
CLAIM DATE : 23/2/88  
SUBJECT TO ADJUSTMENT : N  
CLAIM ACCEPTANCE : Y  
RELATED DOCUMENTS: ER/2/88  
EO/2/88  
EF/2/88

is there any amendments ? -Y/N Y

FIGURE (M-2); DATA ENTRY - CLAIMS REGISTRATION  
GENERAL DATA

```

Claim No. ----- 1
Claim Description ----- 2
Claim Date ----- 3
Subject to Adjustment ----- 4
Claim Acceptance ----- 5
Related Documents ----- 6
Exit ----- 7

```

Which one to amend ? 2

Corrected Claim Description ? UNFORESEEN GROUND CONDITION

```

CLAIM NO. : 1
DESCRIPTION : UNFORESEEN GROUND CONDITION
CLAIM DATE : 23/2/88
SUBJECT TO ADJUSTMENT : N
CLAIM ACCEPTANCE : Y
RELATED DOCUMENTS: ER/2/88
 EO/2/88
 EF/2/88

```

Is there any amendments ? -Y/N N

Claim No. ( 1 ) registered

Is there any more claims ? -Y/N N

FIGURE (M-3); DATA MAINTENANCE - CLAIM  
REGISTRATION GENERAL DATA

CLAIM REGISTRATION OPTIONS:-

=====

```

Editing Claim Registration ----- 1
View Claim Summary ----- 2
Exit ----- 3

```

OPTION ? 2

CLAIMS SUMMARY-VIEW REPORT

=====

| CLAIM NO. | DESCRIPTION                 | DATE    | ACCEPTED |
|-----------|-----------------------------|---------|----------|
| 1         | UNFORESEEN GROUND CONDITION | 23/2/88 | YES      |
| 2         | DELAY DUE LATE DRAWINGS     | 29/2/88 | NO       |

Press <CR> to go back to previous menu.

FIGURE (M-4); VIEW REPORT - CLAIM REGISTRATION  
GENERAL DATA SUMMARY

CLAIM MEASUREMENT OPTIONS:-

\*\*\*\*\*

- Editing Claim Measurement .....1
- View Individual Claim Summary .....2
- View Total Claims Summary .....3
- Exit .....4

OPTION ? 1

Claim No. ? 1

Valuation No. ? 1

Resources Involved :-

\*\*\*\*\*

LABOUR :-

\*\*\*\*\*

Resource No. ? 3

Resource Quantity ? 10

Resource Basic Rate ? 5

Is there any more resources in this type ?-Y/N Y

LABOUR :-

\*\*\*\*\*

Resource No. ? 1

Resource Quantity ? 10

Resource Basic Rate ? 4.25

Is there any more resources in this type ?-Y/N Y

LABOUR :-

\*\*\*\*\*

Resource No. ? 2

Resource Quantity ? 10

Resource Basic Rate ? 8.0

Is there any more resources in this type ?-Y/N N

Addition for Profit/Overhead(I) ? 10

CLAIM NO.:- 1  
 CLAIM DESCRIPTION:-UNFORESEEN GROUND CONDITION  
 CLAIM DATE:- 23/2/88  
 VALUATION NO:- 1

LABOUR  
 \*\*\*\*\*

| RESOURCE NO. | DESCRIPTION                         | QUANTITY | UNIT | RATE | AMOUNT |
|--------------|-------------------------------------|----------|------|------|--------|
| 3            | LABORER                             | 10.00    | HR   | 5.00 | 50.00  |
| 1            | JOHN SMITH                          | 10.00    | HR   | 4.25 | 42.50  |
| 2            | SALIM MASFER                        | 10.00    | HR   | 8.00 | 80.00  |
|              | 10.00% Addition for Profit/Overhead |          |      |      | 12.45  |
| TOTAL AMOUNT |                                     |          |      |      | 191.95 |

Is there any more resources in this type ?-Y/N Y

FIGURE (M-5); DATA ENTRY - EDITING CLAIM MEASUREMENT DATA

Valuation NO. ----- 1  
 Resource No. ----- 2  
 Resource Quantity ----- 3  
 Resource Basic Rate ----- 4  
 Additions Percentage ----- 5  
 Exit ----- 6

Which one to amend ? 5

Corrected Additions Percentage ? 12

CLAIM NO.:- 1  
 CLAIM DESCRIPTION:-UNFORESEEN GROUND CONDITION  
 CLAIM DATE:- 23/2/88  
 VALUATION NO.:- 1

LABOUR  
 =====

| RESOURCE NO. | DESCRIPTION                         | QUANTITY | UNIT | RATE | AMOUNT |
|--------------|-------------------------------------|----------|------|------|--------|
| 31           | LABOURER                            | 10.00    | HR   | 5.00 | 50.00  |
| 1            | JOHN SMITH                          | 10.00    | HR   | 4.25 | 42.50  |
| 2            | SALIM MASSER                        | 10.00    | HR   | 8.20 | 82.00  |
|              | 12.00% Addition for Profit/Overhead |          |      |      | 20.94  |
|              | TOTAL AMOUNT                        |          |      |      | 195.44 |

Is there any amendments ?-Y/N N

FIGURE (M-6); DATA MAINTENANCE - CLAIM REGISTRATION DATA



CLAIM MEASUREMENT OPTIONS:-  
=====

- Editing Claim Measurement -----1
- View Individual Claim Summary -----2
- View Total Claims Summary -----3
- Exit -----4

OPTION \* 2

Wanted Claim No. \* 1

VALUATION NO ( 1 )

=====

CLAIM NO ( 1 ) SUMMARY-VIEW REPORT

=====

| REFS. DESCRIPTION | BASIC COST | PROF/OVH | TOTAL AMOUNT |
|-------------------|------------|----------|--------------|
| LABOUR            | 174.50     | 17.45    | 191.95       |
| PLANT             | 121.74     | 12.17    | 133.91       |
| MATERIAL          | 154.63     | 15.48    | 170.31       |

=====

OVERALL CLAIM TOTAL

496.18

=====

Press <CR> to go back to previous menu.

FIGURE (M-7); VIEW REPORT - INDIVIDUAL CLAIM MEASUREMENT DATA

CLAIM MEASUREMENT OPTIONS:-

- 1
- Editing Claim Measurement -----1
- View Individual Claim Summary -----2
- View Total Claims Summary -----3
- Exit -----4

OPTION ? 3

Wanted Valuation No. ? 1

VALUATION NO. ( 1 )

CLAIMS SUMMARY-VIEW REPORT

| CLAIM NO.                            | DESCRIPTION                 | BASIC TOTAL | ADD.(PT/OV) | OVERALL TOTAL |
|--------------------------------------|-----------------------------|-------------|-------------|---------------|
| 1                                    | UNFORESEEN GROUND CONDITION | 813.90      | 81.39       | 895.34        |
| 2                                    | DELAY DUE LATE DRAWINGS     | 2641.57     | 264.16      | 2905.73       |
| TOTAL FROM CLAIMS FOR VAL. NO. ( 1 ) |                             |             |             | 3801.07       |

Press <CR> to go back to previous menu

FIGURE (M-8); VIEW REPORT - TOTAL CLAIMS MEASUREMENT DATA

## APPENDIX (N)

FIGURES (1-5); SHOW THE FORMS USED IN HANDLING  
THE VARIATION ORDERS ON SITE  
MANUALLY

# FORM OF ARCHITECT'S INSTRUCTION

Architect's name\*  
and address



## Architect's Instruction

Works

situate at

To contractor

Instruction no

Under the terms of the Contract

Date

Dated

I/We issue the following instructions. Where applicable the contract sum will be adjusted in accordance with the terms of the relevant Condition

Instructions

For office use: Approx costs  
£ amt      £ odd

\*The architect's name and address should be printed in the top left hand corner of the instruction form.

Officer's name

Signed \_\_\_\_\_ Architect

Notes

Amount of contract sum £ \_\_\_\_\_  
 ± Approximate value of previous instructions £ \_\_\_\_\_  
 £ \_\_\_\_\_  
 ± Approximate value of this instruction £ \_\_\_\_\_  
 Approximate adjusted total £ \_\_\_\_\_

- To Contractor     Co-ordinate Employer     Quantity surveyor     Clerk of works     Structural consultant   
 Meeting consultant     Electrical consultant             Architect's file

FIGURE (N-1); A SAMPLE OF ARCHITECT'S INSTRUCTION FORM

LETTERS TO CONTRACTORS FIXING APPOINTMENT  
TO MEASURE VARIATIONS

A. NO APPOINTMENT FIXED

Messrs. X, Y & Z.

Date

DEAR SIRs,

Southtown School.

We should like to take the opportunity of beginning the measurement of variations on the above contract, and suggest doing so on Tuesday week, *date*. We should be glad to know if your representative could meet us on the site at, say, 10 a.m. on that day. If not convenient, perhaps you would suggest another day in that week.

Yours faithfully,  
R, S & T

B. APPOINTMENT ARRANGED VERBALLY

Messrs. X, Y & Z.

Date

DEAR SIRs,

Southtown School.

As arranged on the telephone we propose to begin measurement of variations on the above contract next Tuesday week, *date* and understand that your representative will meet us on the site at 10 a.m.

Yours faithfully,  
R, S & T

FIGURE (N-2); A SAMPLE OF THE LETTERS TO  
CONTRACTORS FIXING APPOINTMENT  
TO MEASURE VARIATIONS

LETTER ASKING FOR INVOICES, &c.

Messrs. X, Y & Z.

Date

DEAR SIRs,

Southtown School.

We should be glad to have as soon as possible the following further information to enable us to complete the draft variation account:-

1. Invoices against p.c. and provisional sums as list attached.
2. Daywork sheets covering work in Instructions 16 and 17.
3. Price adjustment (Labour) sheets since *date*.
4. Invoices for sheet lead used. This item on the schedule of basic prices has been omitted from your statement.

Yours faithfully,  
R, S & T.

FIGURE (N-3); A SAMPLE OF CONTRACTOR LETTER ASKING  
FOR INVOICES

**LETTER ENCLOSING DRAFT VARIATION ACCOUNT**

Messrs. X, Y & Z.

Date

DEAR SIRs,

Southtown School.

We are enclosing draft variation account in connection with the above and should be glad if when you have looked through it you will arrange an appointment here to go through any points you have to raise.

You will note that a blank has been left on page 12 for the daywork sheets referred to in our letter of *date* which are still awaited.

Yours faithfully,  
R, S & T.

**22. SUMMARY OF THE VARIATION ACCOUNT**

|      |     |    | <u>Summary.</u>                        | <u>Omissions.</u> | <u>Additions.</u> |
|------|-----|----|----------------------------------------|-------------------|-------------------|
| Item | No. | 1  |                                        | £                 | £                 |
|      |     | 1  | Foundations.                           | 1,573.47          | 1,683.07          |
|      |     | 2  | Drains.                                | 153.16            | 261.36            |
|      |     | 3  | Reinforced Concrete }<br>Construction. | 7,724.80          | 7,910.15          |
|      |     | 4  | Roof Coverings.                        | 1,093.60          | 1,081.50          |
|      |     | 5  | Metal Windows.                         | 3,264.79          | 3,214.34          |
|      |     | 6  | Floor Finishings.                      | 625.14            | 591.55            |
|      |     | 7  | Ironmongery.                           | 273.96            | 312.05            |
|      |     | 8  | Heating and Hot }<br>Water Services.   | 4,729.55          | 5,021.23          |
|      |     | 9  | Electrical Work.                       | 1,295.10          | 1,314.10          |
|      |     | 10 | Sanitary Fittings.                     | 566.50            | 554.05            |
|      |     | 11 | Contingency Provision.                 | 1,500.00          | -                 |
|      |     | 12 | Reduced size of Cloakrooms.            | 329.37            | 21.20             |
|      |     | 13 | Reduced length of Centre Wing.         | 153.12            | 11.47             |
|      |     | 14 | Garden Store.                          | 10.80             | 95.63             |
|      |     | 15 | Plastering to Classrooms.              | 42.08             | 236.35            |
|      |     | 16 | Doors to Assembly Hall }<br>Entrance.  | 56.55             | 134.46            |
|      |     | 17 | Fittings.                              | 233.20            | 376.55            |
|      |     | 18 | Entrance Road.                         | 462.47            | 612.16            |
|      |     |    | Add Water and Insurances }<br>3.50%.   | £ 24,087.66       | £ 23,431.22       |
|      |     |    |                                        | 843.07            | 820.09            |
|      |     |    | Less rebate (see attached)             | £ 24,930.73       | £ 24,251.31       |
|      |     |    | Omission 24,649.71                     |                   |                   |
|      |     |    | Less not subject 19,900.00             |                   |                   |
|      |     |    | 0.14% £4,749.71                        | 6.65              | -                 |
|      |     |    | Additions 23,977.95                    |                   |                   |
|      |     |    | Less not subject 18,675.88             |                   |                   |
|      |     |    | 0.14% £5,302.07                        | -                 | 7.42              |
|      |     |    | Contd.                                 | £ 24,937.38       | £ 24,258.73       |

**FIGURE (N-4) ; A SAMPLE OF DRAFT VARIATION ACCOUNT WITH ITS ATTACHED LETTER**

|                                      | <u>Omissions</u> | <u>Additions</u> |
|--------------------------------------|------------------|------------------|
| Price Adjustment Formula             | £ 24,937.38      | £ 24,258.73      |
| Contd                                | -                | 3,745.08         |
|                                      | £ 24,937.38      | £ 28,003.81      |
|                                      | -                | 24,937.38        |
| Net Addition<br>Earned to Statement. |                  | £ 3,066.43       |
| <u>STATEMENT</u>                     |                  |                  |
| Amount of Contract.                  | £ 188,250.00     |                  |
| Net Addition as above.               | 3,066.43         |                  |
|                                      | £ 191,316.43     |                  |
| <u>Calculation of Rebate.</u>        |                  |                  |
| <u>Items not subject to rebate.</u>  |                  |                  |
|                                      | <u>£</u>         | <u>£</u>         |
| Item No. 3                           | 7,500.00         | 7,594.10         |
| 4                                    | 1,000.00         | 995.71           |
| 5                                    | 3,000.00         | 2,934.89         |
| 6                                    | 400.00           | 412.60           |
| 7                                    | 250.00           | 269.62           |
| 8                                    | 4,500.00         | 4,712.10         |
| 9                                    | 1,200.00         | 1,210.03         |
| 10                                   | 550.00           | 546.83           |
| 11                                   | 1,500.00         | -                |
|                                      | £ 19,900.00      | £ 18,675.88      |

FIGURE (N-4 CONTINUED)

**LETTER ENCLOSING FINALLY CORRECTED  
VARIATION ACCOUNT**

Messrs. X, Y & Z. Date

DEAR SIRs.

Southtown School.

We are now enclosing variation account, in which we have incorporated the amendments made at our recent meeting, showing a total of ..... We should be glad if you will sign page 54 confirming your agreement to this figure subject to audit and return to us, so that we can submit it to the Architect for approval.

Yours faithfully,  
R. S & T.

FIGURE (N-5); A SAMPLE OF LETTER ENCLOSING FINAL VARIATION ACCOUNT

## APPENDIX (O)

FIGURES (1-6); SHOW THE DATA ENTRY OF "VARIATION ORDERS CONTROL" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF USER INPUTS.



To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ----3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION CG9 SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 MANSFIELD ROAD  
DERBY  
DERRYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY,  
DERRYSHIRE,  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

\*\*\*\*< Main Menu >\*\*\*\*

Options:-

-----  
Data Preparation -----1  
Bonusing Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 11

FIGURE (O-1); SYSTEM ENTRY - "VARIATION ORDERS"  
FUNCTION

VARIATION OPTION:

=====

Editing Variation Orders ----- 1  
Editing Variation Orders Items ----- 2  
View Variation Orders Summary ----- 3  
Variation Orders Accounts ----- 4  
Exit ----- 5

Option ? 1

Variation Order No. ? 2

Is it a new order ?-Y/N Y

Date of Issue ? 18/2/88

V.O. Description ? CHANGING DRAWING NO 23/LUTTO 988

Architect/Engineer Instruction No. ? 2

Related Reference Code ? HGR/JH

VARIATION ORDER NO.: 2

=====

DESCRIPTION : CHANGING DRAWING NO 23/LUTTO 988

=====

DATE OF ISSUE: 18/2/88

=====

INSTRUCTION NO.: 2

=====

REFERENCE CODE: HGR/JH

-----

AM ----- To amend

FI ----- To file

EX ----- To exit

AM

FIGURE (O-2); DATA ENTRY - EDITING VARIATION ORDER GENERAL DATA

Variation Order No. ----- 1  
Date of Issue ----- 2  
U.O. Description ----- 3  
Architect/Engineer Instruction No. ----- 4  
Related reference Code ----- 5  
Exit ----- 6

Which one to amend ? 4

Corrected Architect/Engineer Instruction No. ? 4

VARIATION ORDER NO.: 2

=====

DESCRIPTION : CHANGING DRAWING NO 23/LOTTO 988

=====

DATE OF ISSUE: 18/2/88

=====

INSTRUCTION NO.: 4

=====

REFERENCE CODE: HGR/JH

=====

AM ----- To amend

FI ----- To file

FY ----- To exit

FI

Variation Order No. ( 2 ) filed.

Is there any more variation orders ?-Y/N N

FIGURE (O-3); DATA MAINTENANCE - VARIATION  
ORDER GENERAL DATA

```

Listing Variation Orders 1
Editing Variation Orders Items 2
View Variation Orders Summary 3
Variation Orders Accounts 4
Exit 5

```

```

Option ? 2
Variation Order No. ? 1
Item Code ? 212R
Variation Order Page No. ? 1
Variation Order Item No. ? 1

```

```

BOO ITEM CODE : 212R

REMOVAL OF EXISTING SEWER OF
DRAINS 150MM DIAMETER

```

```

V.O. Item No. ----- 1
Variation Order Page ----- 1
Item Unit ----- M
Item Old Rate ----- 5.00
Item New Rate ----- 5.00
Item Old Quantity ----- 100.00
Item New Quantity ----- 100.00

```

```

VARIATION REQUIREMENTS :

Amend Item Quantity ----- 1
Amend Item Rate ----- 2
Exit ----- 3
<CR> -- to continue

```

```

Which one to amend ? 1

```

```

TYPES OF AMENDMENTS:

Add to BOO Figures ----- 1
Subtract from BOO Figures ----- 2
Replace BOO Figures ----- 3
Exit ----- 4

```

```

Amendment ? 2
Subtracted Quantity ? 5

```

```

BOO ITEM CODE : 212R

REMOVAL OF EXISTING SEWER OF
DRAINS 150MM DIAMETER

```

```

V.O. Item No. ----- 1
Variation Order Page ----- 1
Item Unit ----- M
Item Old Rate ----- 5.00
Item New Rate ----- 5.00
Item Old Quantity ----- 100.00
Item New Quantity ----- 95.00

```

```

VARIATION REQUIREMENTS :

Amend Item Quantity ----- 1
Amend Item Rate ----- 2
Exit ----- 3
<CR> -- to continue

```

```

Which one to amend ?
Is there any more items included ?-Y/N N
Do you want to file the V.O. ?-Y/N Y
Variation Order No. (1) filed.

```

FIGURE (O-4); DATA ENTRY - VARIATION ORDER ITEMS DATA

VARIATION OPTION:  
=====

- Editing Variation Orders ----- 1
- Editing Variation Orders Items ----- 2
- View Variation Orders Summary ----- 3
- Variation Orders Accounts ----- 4
- Exit ----- 5

Option 3

VARIATION ORDERS SUMMARY-VTEU REPORT  
=====

| V.O. NO. | V.O. DESCRIPTION                                      | DATE    | TMS. NO. | REF. CODE |
|----------|-------------------------------------------------------|---------|----------|-----------|
| 1        | REPLACE DRAWING NO. 1UT/14 WITH<br>DRAWING NO. 1UT/27 | 8/2/88  | 2        | FR/LUT/96 |
| 2        | CHANGING DRAWING NO 23/LUTTO 966                      | 18/2/88 | 4        | HGR/JH    |

Press <CR> to go back to previous menu.

FIGURE (O-5); VIEW REPORT - VARIATION ORDER SUMMARY

VARIATION OPTION:

=====

- Editing Variation Orders ----- 1
- Editing Variation Orders Items ----- 2
- View Variation Orders Summary ----- 3
- Variation Orders Accounts ----- 4
- Exit ----- 5

Option ? 4

Required Variation Order No. ? 1

U.O. NO. 2 : REPLACE DRAWING NO. LUT/14 WITH DRAWING NO. LUT/27  
DATE OF ISSUE : 8/2/88

SUMMARY OF VARIATIONS

=====

| ITEM NO.                  | NATURE OF WORK                                         | UNIT | OMISSIONS | ADDITIONS |
|---------------------------|--------------------------------------------------------|------|-----------|-----------|
| 1                         | 2REMOVAL OF EXISTING SEWER OF<br>DRAINS 150MM DIAMETER | M    | 25.00     |           |
| 2                         | 7UNTENSIONED SINGLE SIDED OPEN<br>BOX BEAM             | M    |           | 130.50    |
| 3                         | 9CONCRETE GROUND BEAM WITH SOCKETS<br>AT 1.2M CENTRES  | M    | 101.06    |           |
|                           |                                                        |      | 126.06    | 130.50    |
|                           |                                                        |      |           | 126.06    |
|                           |                                                        |      |           | =====     |
| NET VARIATION ORDER TOTAL |                                                        |      |           | 4.44      |

Press <CR> to go back to previous menu.

FIGURE (O-6); VIEW REPORT - VARIATION ORDERS ACCOUNTS

## APPENDIX (P)

FIGURES (1-4); SHOW DATA ENTRY OF "DAYWORK CONTROL" FUNCTION WITH ITS ON-SCREEN REPORTS, AS DIALOGUES BETWEEN "PLUS COST" AND THE USER. THE UNDERLINED TEXT ARE SAMPLES OF THE USER INPUTS.

To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ----3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION CBS SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 HANSFIELD ROAD  
DERBY  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY,  
DERBYSHIRE,  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

=====

Press <CR> to go into the system.

\*\*\*\*< Main Menu >\*\*\*\*

Options:-

-----  
Data Preparation -----1  
Bonusing Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 9

FIGURE (P-1); SYSTEM ENTRY - "DAYWORK" FUNCTION



DAYWORK SHEET DATA

Editing Daywork Sheets ..... 1  
View Daywork Sheets ..... 2  
Exit ..... 3

Which One do you want ? 1

Contract Number ? 1

Site Instruction No. ? 10

Description of Works ? EARTH MOVING

Commencing Date ? 28/2/88

Completing Date ? 28/8/88

Daywork Sheet No. ? 1

Activity/Cost Center No. ? 1

Section No. ? 1

LABOUR RESOURCES:-

Resource No. ? 2

Resource Quantity ? 8

Resource Basic Rate ? 8.25

Rate Additions for Profit/Overhead etc.(%) ? 10

Is there any more Labour Resources ? -Y/N Y

LABOUR RESOURCES:-

Resource No. ? 23

Resource Quantity ? 8

Resource Basic Rate ? 5.2

Rate Additions for Profit/Overhead etc.(%) ? 10

Is there any more Labour Resources ? -Y/N Y

LABOUR RESOURCES:-

Resource No. ? 24

Resource Quantity ? 8

Resource Basic Rate ? 8.25

Rate Additions for Profit/Overhead etc.(%) ? 10

Is there any more Labour Resources ? -Y/N N

CONTRACT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
DISCRIPTION OF WORKS: EARTH MOVING  
COMMENCING DATE: 28/2/88  
COMPLETING DATE: 28/8/88

CONTRACT NO.: 1  
SHEET NO.: 1  
SITE INS. NO.: 10

DAYWORK SHEET (LABOUR RESOURCESPL)

| NO.   | DESCRIPTION   | QUANTITY | UNIT | RATE | PROFIT % | AMOUNT |
|-------|---------------|----------|------|------|----------|--------|
| 2     | SALIM WASSER  | 8.00     | HR   | 8.25 | 10.00    | 72.16  |
| 23    | JASIM KHALIFA | 8.00     | HR   | 5.20 | 10.00    | 45.76  |
| 24    | SAAD ABDULLAH | 8.00     | HR   | 8.25 | 10.00    | 72.60  |
| TOTAL |               |          |      |      |          | 190.52 |

Is there any amendment required ? -Y/N Y

Daywork Sheet No. ( 1 ) filed.

Is there any more Daywork Sheets ? -Y/N N

FIGURE (P-2); DATA ENTRY - DAYWORK SHEET DATA

Resource No. ----- 1  
 Resource Quantity ----- 2  
 Resource Basic Rate ----- 3  
 Rate Addition for profit etc. ----- 4  
 Description of Works ----- 5  
 Sheet No. ----- 6  
 Site Instruction No. ----- 7  
 Commencing Date ----- 8  
 Completing Date ----- 9  
 Exit ----- 10

Which one to amend ? 9

Corrected Completion Date ? 28/2/88

CONTRACT: BALFOUR BEATTY CONSTRUCTION CGS SYSTEM  
 DISCRIPTION OF WORKS: EARTH MOVING  
 COMMENCING DATE: 28/2/88  
 COMPLETING DATE: 28/2/88

CONTRACT NO.: 1  
 SHEET NO.: 1  
 SITE INS. NO.: 10

DAYWORK SHEET (LABOUR RESOURCESPL)  
 =====

| NO.   | DESCRIPTION   | QUANTITY | UNIT | RATE | PROFIT % | AMOUNT |
|-------|---------------|----------|------|------|----------|--------|
| 2     | SALIM MASSER  | 8.00     | HR   | 8.20 | 10.00    | 72.16  |
| 23    | JASIM KHALIFA | 6.00     | HR   | 5.26 | 10.00    | 45.76  |
| 24    | SHAD ABDULLAH | 8.00     | HR   | 8.25 | 10.00    | 72.60  |
| TOTAL |               |          |      |      |          | 190.52 |

Is there any amendment required ? -Y/N N

Do you want to file the data ? -Y/N Y

FIGURE (P-3); DATA MAINTENANCE - DAYWORK SHEET DATA

DAYWORK SHEET OPTIONS:-

=====

Editing Daywork Sheets ----- 1  
 View Daywork Sheets ----- 2  
 Exit ----- 3

Which One do you want ? 2

The Required Daywork Sheet No. ? 1

CONTRACT NO.: 1  
 DESCRIPTION OF WORK: EARTH MOVING  
 COMMENCING DATE: 28/2/88  
 COMPLETING DATE: 28/2/88

SHEET NO.: 1  
 SITE INSL NO.: 10

LABOUR RESOURCES

=====

| NO.   | DESCRIPTION   | QUANTITY | UNIT | RATE | PROFIT % | AMOUNT |
|-------|---------------|----------|------|------|----------|--------|
| 2     | SALIM NASSER  | 8.00     | HR   | 8.20 | 10.00    | 72.16  |
| 23    | JASIM KHALIFA | 8.00     | HR   | 5.20 | 10.00    | 45.76  |
| 24    | SAAD ABDULLAH | 8.00     | HR   | 6.25 | 10.00    | 72.60  |
| TOTAL |               |          |      |      |          | 190.52 |

PLANT RESOURCES

=====

| NO.   | DESCRIPTION | QUANTITY | UNIT | RATE  | PROFIT % | AMOUNT |
|-------|-------------|----------|------|-------|----------|--------|
| 8     | BORCAT 500  | 7.00     | HR   | 7.84  | 10.00    | 60.37  |
| 9     | COMPRESSOR  | 6.00     | HR   | 5.70  | 10.00    | 37.62  |
| 28    | SCRAPER     | 3.00     | HR   | 30.75 | 10.00    | 101.47 |
| TOTAL |             |          |      |       |          | 199.46 |

MATERIAL RESOURCES

=====

| NO.   | DESCRIPTION | QUANTITY | UNIT | RATE  | PROFIT % | AMOUNT |
|-------|-------------|----------|------|-------|----------|--------|
| 50    | BRICKS      | 1000.00  | NR   | 0.15  | 10.00    | 165.00 |
| 52    | SILT        | 0.50     | M3   | 2.60  | 10.00    | 1.54   |
| 53    | CEMENT      | 0.80     | M3   | 19.25 | 10.00    | 16.94  |
| 151   | SAND        | 1.80     | M3   | 2.75  | 10.00    | 5.44   |
| TOTAL |             |          |      |       |          | 188.92 |

-----  
 THE OVERALL TOTAL 578.90  
 -----

Press <CR> to go back the previous menu.

FIGURE (P-4); VIEW REPORT - DAYWORK SHEET

## APPENDIX (Q)

FIGURES (1-8); SHOW THE DATA ENTRY OF "PRICE ADJUSTMENT" FUNCTION FOR BOTH TYPE OF CONTRACT (CIVIL ENG. AND BUILDING WORK). AS DIALOGUES BETWEEN THE USER AND "PLUS COST". THE UNDERLINED TEXT ARE SAMPLES OF USER INPUT

To Enter Base Month Index -----1  
To Maintain Series(2) Indices -----2  
To Exit -----3

Option ? 1

PRICE ADJUSTMENT FOR BUILDING CONTRACTS  
\*\*\*\*\*

WORK GROUP METHOD  
\*\*\*\*\*

BASIC MONTH INDEX  
\*\*\*\*\*

Indices Date(Mon/Year, F1/F2) ? 2/86

Work Group ? A

Work Category No. ? 1

Index Figure ? 260

Work Category No. ? 2

Index Figure ? 258

Work Category No. ? 3

Index Figure ? 271

Work Category No. ?

Work Group ? B

Work Category No. ? 4

Index Figure ? 269

Work Category No. ? 5

Index Figure ? 229

Work Category No. ? 6

Index Figure ? 268

Work Category No. ? 7

Index Figure ? 245

Work Category No. ? 8

Index Figure ? 273

Work Category No. ?

Work Group ?

Is there any amendment ?-Y/N Y

Which work group to amend ? A

PRICE ADJUSTMENT FOR BUILDING CONTRACTS  
\*\*\*\*\*

WORK GROUP METHOD  
\*\*\*\*\*

BASIC MONTH INDICES - 2/86  
\*\*\*\*\*

WORK GROUP: ? A ?

| CAT.<br>NO. | IND.<br>FIG. |
|-------------|--------------|
|-------------|--------------|

|   |        |
|---|--------|
| 1 | 260.00 |
|---|--------|

|   |        |
|---|--------|
| 2 | 258.00 |
|---|--------|

|   |        |
|---|--------|
| 3 | 271.00 |
|---|--------|

Work Group ----- 1  
Category No. ----- 2  
Indices Figure ----- 3  
Indices Date ----- 4  
Exit ----- 5

Which one to amend ? 1

Is there any amendment ?-Y/N Y

FIGURE (Q-1); DATA ENTRY - BASE MONTH  
SERIES (2) INDICES

```

To Enter Base Month Index -----1
To Maintain Series(2) Indices -----2
To Exit -----3

Option * 2

PRICE ADJUSTMENT FOR BUILDING CONTRACTS
=====
WORK GROUP METHOD
=====
SERIES(2) INDICES
=====

Indices Date (Month/Year, ##/##) ?

Is it a new indices ? Y

Work Group ? A

Work Category No. ? 1
Index Figure ? 258

Work Category No. ? 2
Index Figure ? 256

Work Category No. ? 3
Index Figure ? 277

Work Category No. ? 4
Index Figure ? 270

Work Category No. ?

Work Group ? B

Work Category No. ? 4
Index Figure ? 270

Work Category No. ? 5
Index Figure ? 219

Work Category No. ? 6
Index Figure ? 271

Work Category No. ? 7
Index Figure ? 245

Work Category No. ? 8
Index Figure ? 277

Work Category No. ?

Work Group ?

```

FIGURE (Q-2); DATA ENTRY - MONTHLY SERIES (2) INDICES DATA

Is there any amendment ?-Y/N Y

Which work group to amend ? B

PRICE ADJUSTMENT FOR BUILDING CONTRACTS

-----

WORK GROUP METHOD

-----

SERIES(2) INDICES - 3/86

-----

FINAL INDICES

-----

WORK GROUP: ( B )

-----

| CAT. NO. | IND. FIG. |
|----------|-----------|
| 4        | 270.00    |
| 5        | 219.00    |
| 6        | 271.00    |
| 7        | 245.00    |
| 8        | 277.00    |

Work Group ----- 1

Category No. ----- 2

Indices Figure ----- 3

Indices Date ----- 4

Exit ----- 5

Which one to amend ? 3

Whose indices figure to amend ? 4

Corrected Indices Figure ? 271

PRICE ADJUSTMENT FOR BUILDING CONTRACTS

-----

WORK GROUP METHOD

-----

SERIES(2) INDICES - 3/86

-----

FINAL INDICES

-----

WORK GROUP: ( B )

-----

| CAT. NO. | IND. FIG. |
|----------|-----------|
| 4        | 271.00    |
| 5        | 219.00    |
| 6        | 271.00    |
| 7        | 245.00    |
| 8        | 277.00    |

Work Group ----- 1

Category No. ----- 2

Indices Figure ----- 3

Indices Date ----- 4

Exit ----- 5

Which one to amend ? 5

Is there any more amendment ?-Y/N N

Are they final indices ?-Y/N Y

Series(2) indices - 3/86 - final.

FIGURE (Q-3); DATA MAINTENANCE - MONTHLY SERIES (2) INDICES DATA

To Enter Base Month Index -----1  
 To Maintain Series(2) Indices -----2  
 To Exit -----3

Option \* 2

PRICE ADJUSTMENT FOR BUILDING CONTRACTS  
 \*\*\*\*\*  
 WORK GROUP METHOD  
 \*\*\*\*\*  
 SERIES(2) INDICES  
 \*\*\*\*\*

Indices Date (Month/Year, (1/64)) \* 3/86

Is it a new indices ? N

Which work group to amend \* B

PRICE ADJUSTMENT FOR BUILDING CONTRACTS  
 \*\*\*\*\*  
 WORK GROUP METHOD  
 \*\*\*\*\*  
 SERIES(2) INDICES - 3/86  
 \*\*\*\*\*

FINAL INDICES

\*\*\*\*\*  
 WORK GROUP: ( B )  
 \*\*\*\*\*

| CAT. NO. | IND. FIG. |
|----------|-----------|
| 4        | 271.00    |
| 5        | 219.00    |
| 6        | 271.00    |
| 7        | 245.00    |
| 8        | 277.00    |

Work Group ----- 1  
 Category No. ----- 2  
 Indices Figure ----- 3  
 Indices Date ----- 4  
 Exit ----- 5

Which one to amend \* 3

Whose indices figure to amend \* 4

Connected Indices figure \* 270

PRICE ADJUSTMENT FOR BUILDING CONTRACTS  
 \*\*\*\*\*  
 WORK GROUP METHOD  
 \*\*\*\*\*  
 SERIES(2) INDICES - 3/86  
 \*\*\*\*\*

FINAL INDICES

\*\*\*\*\*  
 WORK GROUP: ( B )  
 \*\*\*\*\*

| CAT. NO. | IND. FIG. |
|----------|-----------|
| 4        | 270.00    |
| 5        | 219.00    |
| 6        | 271.00    |
| 7        | 245.00    |
| 8        | 277.00    |

Work Group ----- 1  
 Category No. ----- 2  
 Indices Figure ----- 3  
 Indices Date ----- 4  
 Exit ----- 5

Which one to amend \* 5

Is there any more amendment ? Y/N N

Are they final indices ? Y/N Y  
 Indices - 3/86 ----- filed

FIGURE (Q-4); DATA MAINTAIN - SERIES (2)  
 INDICES DATA



To Enter Base Month Indices ..... 1  
 To Maintain Baxter Indices ..... 2  
 To Exit ..... 3

Option ? 1

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS  
 \*\*\*\*\*  
 BAXTER METHOD  
 \*\*\*\*\*  
 BASIC MONTH INDICES  
 \*\*\*\*\*

Indices Date (Month/Year,--/--) ? 1/.86

Work Category No. ? 1

Index Figure ? 557.5

Work Category No. ? 2

Index Figure ? 531.6

Work Category No. ? 3

Index Figure ? 844.5

Work Category No. ? 4

Index Figure ? 987.1

Work Category No. ? 5

Index Figure ? 672.4

Work Category No. ? 6

Index Figure ? 779.6

Work Category No. ? 7

Index Figure ? 999.7

Work Category No. ? 8

Index Figure ? 634.9

Work Category No. ? 9

Index Figure ? 876.2

Work Category No. ? 11

Index Figure ? 502.7

Work Category No. ? 12

Index Figure ? 506.7

Work Category No. ?

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS  
 \*\*\*\*\*  
 BAXTER METHOD  
 \*\*\*\*\*  
 BASIC MONTH INDICES  
 \*\*\*\*\*

DATE : 1/.86

CAT. NO. INDEX FIG.

|    |        |
|----|--------|
| 1  | 557.50 |
| 2  | 531.60 |
| 3  | 844.50 |
| 4  | 987.10 |
| 5  | 672.40 |
| 6  | 779.60 |
| 7  | 999.70 |
| 8  | 634.90 |
| 9  | 876.20 |
| 11 | 502.70 |
| 12 | 506.70 |

Is there any agreement ?-Y/N N

Basic Month Indices filed.

FIGURE (Q-5); DATA ENTRY - BASE MONTH BAXTER INDICES DATA

To Enter Base Month Indices ..... 1  
 To Modify Baxter Indices ..... 2  
 To Exit ..... 3

Option ? 2

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS

BAXTER METHOD

BAXTER INDICES

Index Date (Month/Year, etc) ? 3/86

Is it a new indices ?-Y/N Y

Work Category No. ? 1

Index Figure ? 557.6

Work Category No. ? 2

Index Figure ? 531.6

Work Category No. ? 3

Index Figure ? 864.9

Work Category No. ? 4

Index Figure ? 943.3

Work Category No. ? 5

Index Figure ? 674.0

Work Category No. ? 6

Index Figure ? 781.2

Work Category No. ? 7

Index Figure ? 998.3

Work Category No. ? 8

Index Figure ? 578.7

Work Category No. ? 9

Index Figure ? 876.9

Work Category No. ? 10

Index Figure ? 592.0

Work Category No. ? 11

Index Figure ? 217.7

Work Category No. ?

Are they firm indices ?-Y/N Y

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS

BAXTER METHOD

BAXTER INDICES

FINAL INDICES - 3/86

CAT. NO. IND. FIG.

|    |        |
|----|--------|
| 1  | 557.60 |
| 2  | 531.60 |
| 3  | 864.90 |
| 4  | 943.30 |
| 5  | 674.00 |
| 6  | 781.20 |
| 7  | 998.30 |
| 8  | 578.70 |
| 9  | 876.90 |
| 10 | 592.00 |
| 11 | 217.70 |

Is there any amendment ?-Y/N N

Are they firm indices ?-Y/N Y

Baxter Indices - 3/86 - filed.

FIGURE (Q-6); DATA ENTRY - MONTHLY BAXTER INDICES DATA

To Enter Base Month Indices ----- 1  
 To Maintain Baxter Indices ----- 2  
 To Exit ----- 3

Option \* 1  
 Basic Month Indices already filed, if you want  
 to maintain it, go through Maintain Baxter Indices in previous  
 menu

To Enter Base Month Indices ----- 1  
 To Maintain Baxter Indices ----- 2  
 To Exit ----- 3

Option \* 2

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS  
 \*\*\*\*\*

BAXTER METHOD  
 \*\*\*\*\*  
 BAXTER INDICES  
 \*\*\*\*\*

Index Date (Month/Year,YY/YY) \* 1/1986

Is it a new indices ?-Y/N N

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS  
 \*\*\*\*\*

BAXTER METHOD  
 \*\*\*\*\*  
 BAXTER INDICES  
 \*\*\*\*\*

BASIC ----- - 1/1986

\*\*\*\*\*  
 CAT. NO. IND. FIG.

|    |        |
|----|--------|
| 1  | 557.50 |
| 2  | 531.60 |
| 3  | 844.50 |
| 4  | 907.10 |
| 5  | 672.40 |
| 6  | 771.00 |
| 7  | 989.90 |
| 8  | 634.90 |
| 9  | 876.20 |
| 11 | 582.70 |
| 12 | 506.70 |

Is there any amendment ?-Y/N Y  
 Work Category No. ----- 1  
 Index Figure ----- 2  
 Indices Date ----- 3  
 Exit ----- 4  
 Which one to amend \* 3

Corrected Date \* 2/1986

PRICE ADJUSTMENT FOR CIVIL ENG. CONTRACTS  
 \*\*\*\*\*

BAXTER METHOD  
 \*\*\*\*\*  
 BAXTER INDICES  
 \*\*\*\*\*

BASIC ----- - 2/1986

\*\*\*\*\*  
 CAT. NO. IND. FIG.

|    |        |
|----|--------|
| 1  | 557.50 |
| 2  | 531.60 |
| 3  | 844.50 |
| 4  | 907.10 |
| 5  | 672.40 |
| 6  | 771.00 |
| 7  | 989.90 |
| 8  | 634.90 |
| 9  | 876.20 |
| 11 | 582.70 |
| 12 | 506.70 |

Is there any amendment ?-Y/N N

Are they firm indices ?-Y/N Y

FIGURE (Q-7); DATA MAINTAIN - MONTHLY  
 BAXTER INDICES

```

To work on an Existing Contract -----1
To work on a New Contract -----2
To work on Building Construction Indices ----3
To work on Civil Eng. Construction Indices --4
To Exit from the System -----5

Which one do you want ? 1

Contract: Assess

*** Main Menu ***

Options:-
Data Preparation -----1
Cost Calculations -----2
Material Control -----3
Preliminaries Control --4
Drawings Sheets -----5
Claims -----6
Variation Orders -----7
Editing Data -----8
Preparing Reports -----9
Exit -----10

Which do you want ? 1

Options:-
Bill Items Data -----1
BOQ Valuation Data -----2
Resources Data -----3
Sub-Contractors Data -----4
Activities Data -----5
Sections Data -----6
Unfixed Material Data -----7
Engineer's Assessment for Price Adjustment --8
Exit -----9

Which do you want ? 8

Contract No. 1

Engineer's Assessment of The Breakdown of The Contract Value

Item 2

Labour 15
Plant 20
Aggregates 6
Bricks and Clay Products 1
Cements 2
Cast Iron Products 8
Coated Roadstone 15
[ERU Fuel] 3
Gas Oil Fuel 4
Timber Generally 4
[Reinforcement Steel] 1
Metal Sections 1
[Structural Steel] 1
[Steelwork Components] 0

As per Percentage of the Asst. Elements: 10

Contract No. Assess

Engineer's Assessment of The Breakdown of The Contract Value

```

FIGURE (Q-8); DATA ENTRY - ENGINEER'S ASSESSMETN OF BREAKDOWN FIGURES

## APPENDIX (R)

FIGURES (1-5); SHOW THE FEEDBACK FACILITY  
IN "PLUS COST" WITH ITS  
PRINT-OUT REPORTS. THE  
UNDERLINED TEXT ARE SAMPLES  
OF THE USER INPUT.

To Work on an Existing Contract -----1  
To Work on a New Contract -----2  
To Work on Building Construction Indices ----3  
To Work on Civil Eng. Construction Indices --4  
To Exit from the System -----5

Which one do you want ? 1

Contract No. required to work on ? 1

Contract Password ?

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION COS SYSTEM  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
55 MANSFIELD ROAD  
DERBY  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: JERARD WOLKER  
57 BUCKINGHAM DRIVE  
DERBY,  
DERBYSHIRE,  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

-----  
Press <CR> to go into the system.

\*\*\*\*\*( Main Menu )\*\*\*\*

Options:-  
-----

Data Preparation -----1  
Bonusing Indices Data -----2  
Labour Control -----3  
Plant Control -----4  
Material Control -----5  
Subcontractors Control -----6  
Preliminaries Control -----7  
On-Cost Overheads Control -----8  
Daywork Sheets -----9  
Claims -----10  
Variation Orders -----11  
Preparing Reports -----12  
Feedback Comments -----13  
Exit -----14

Which do you want ? 13

FIGURE (R-1); SYSTEM ENTRY - FEEDBACK COMMENTS SELECTION

Monitoring Feedback Reports:-

=====

|                                        |   |
|----------------------------------------|---|
| Cost Monitoring Reports -----          | 1 |
| Value Monitoring Reports -----         | 2 |
| Cost-Value Monitoring Reports -----    | 3 |
| Budget Costing Reports -----           | 4 |
| Weekly Cost Center Reports -----       | 5 |
| Short Term Planning Reports -----      | 6 |
| Overall Project Preliminary Reports -- | 7 |
| Material Control Reports -----         | 8 |
| Exit -----                             | 9 |

Which report the comments required on ? 8

Material Reports Options:-

=====

|                                   |   |
|-----------------------------------|---|
| Material Wastage Report -----     | 1 |
| Material Utilization Report ----- | 2 |
| Exit -----                        | 3 |

On which report the comments required ? 1

The Comments Date (dd/mm/yy) ? 12/3/88

Personnel's Position On-Site ? GENERAL FOREMAN

List The Comments as points up to 20 points:-

- 1-Bad usage of material No.52 on site near the workarea.
- 2-The quality of the material No. 52 not as expected.
- 3-Most of the material No.52 wasted through the unloading.

4-

FIGURE (R-2); DATA ENTRY - SITE PERSONNEL FEEDBACK COMMENTS ON ONE OF THE SYSTEM CONTROL RESULTS.

MONTHLY BASIS MATERIAL WASTAGE MONITORING STATEMENT

CONTRACT ( 1 ) : RALEFOUR BEATTY CONSTRUCTION COS SYSTEM

MONTH : 2/88

| RES. NO. | DESCRIPTION          | UNIT | COST CODE | DELIVERED QUANTITY | MEASURED QUANTITY | UNFIXED QUANTITY | OTHER USED QUANTITY | MATERIAL IN STOCK | MATERIAL ESTIMAT. WASTE % ALLOW. | %     | REMARK      |
|----------|----------------------|------|-----------|--------------------|-------------------|------------------|---------------------|-------------------|----------------------------------|-------|-------------|
| 52       | SILT                 | IM3  | 11        | 550.00             | 10.00             | 20.00            | 10.00               | 420.00            | 16.36                            | 10.75 | ABOVE LIMIT |
| 58       | MILD STEEL 10MM DIA. | IM3  | 11        | 170.00             | 1.00              | 5.00             | 0.00                | 164.00            | 0.00                             | 5.97  | BELOW LIMIT |

COMMENT DATE: 17/3/88

PERSONNEL'S POSITION ON-SITE: GENERAL FOREMAN

THE COMMENTS ARE:-

- 1- Bad usage of the material No. 52 on site near the work area.
- 2- The quality of material No. 52 not as expected.
- 3- Most of the material No. 52 wasted through the unloading.

COMMENT DATE: 20/3/88

PERSONNEL'S POSITION ON-SITE: SITE ENGINEER

THE COMMENTS ARE:-

- 1- Bad usage of the material No. 52 on site.
- 2- Most of material No. 52 wastage is from the unloading.

FIGURE (R-3) : A SAMPLE OF THE SITE PERSONNEL FEEDBACK COMMENTS ON ONE OF THE SYSTEM CONTROL REPORTS.



Options:-

- Data Preparation -----1
- Bonusing Indices Data -----2
- Labour Control -----3
- Plant Control -----4
- Material Control -----5
- Subcontractors Control -----6
- Preliminaries Control -----7
- Un-Cost Overheads Control -----8
- Daywork Sheets -----9
- Claims -----10
- Variation Orders -----11
- Preparing Reports -----12
- Feedback Comments -----13
- Exit -----14

Which do you want ? 12

THE REPORT OPTIONS:-

-----

- Cost Monitoring Reports ----- 1
- Value Monitoring Reports ----- 2
- Cost-Value Monitoring Reports ----- 3
- Budget Cost Reports ----- 4
- Weekly BoO Costing Reports ----- 5
- Graphical Reports ----- 6
- Short Term Planning Report ----- 7
- Material Usage Reports ----- 8
- Preliminary Overall Project Report ----- 9
- Feedback Reports to The Estimator ----- 10
- Exit to The Main Menu ----- 11

The Required Option ? 10

Required Cost Center Code ? 1

Required Valuation No. ? 1

INTERIM FEEDBACK REPORT IN PROGRESS  
++++ PLEASE WAIT ++++

THE ESTIMATOR FEEDBACK REPORT IS READY ON " FILE.19 " FILE...

Press <CR>, to go back to the previous menu....

FIGURE (R-4); SYSTEM ENTRY - FEEDBACK REPORT TO THE ESTIMATOR

INTERIM FEEDBACK STATEMENT  
 \*\*\*\*\*

VAL. DATE: 2/88

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION CRS SYSTEM

COST CENTER ( 1 ) : TEMPORARY ACCOMMODATION

| BILL ITEM     | UNIT | QUANTITY | LABOUR  | PLANT  | MATERIAL | SUBCONT. | PRELIMIN. | TOTAL RATE | TOTAL    |
|---------------|------|----------|---------|--------|----------|----------|-----------|------------|----------|
| 111E          | NO   | 1.00     | 207.43  | 207.43 | 207.00   | 207.00   | 207.00    | 187.46     | 1035.91  |
| 111A          | SUM  | 1.00     | 715.78  | 715.78 | 716.63   | 715.78   | 715.84    | 650.45     | 3579.81  |
| 111F          | SUM  | 1.00     | 1.00    | 1.00   | 1.00     | 1.00     | 1.00      | 0.00       | 5.00     |
| 111B          | SUM  | 1.00     | 272.03  | 271.38 | 271.58   | 271.38   | 271.44    | 246.05     | 1357.61  |
| 111C          | SUM  | 1.00     | 200.40  | 200.36 | 200.78   | 200.23   | 200.28    | 179.31     | 1002.05  |
| 111D          | SUM  | 1.00     | 826.00  | 826.00 | 826.18   | 826.70   | 826.03    | 750.75     | 4130.91  |
| COST INCURRED |      |          |         |        |          |          |           |            |          |
|               |      |          | 1784.45 | 366.14 | 200.20   | 963.05   | 60.30     |            | 3394.14  |
| BUDGET TOTAL  |      |          |         |        |          |          |           |            | 11111.49 |
| COST          |      |          |         |        |          |          |           |            | 7717.35  |
| VARIANCE      |      |          |         |        |          |          |           |            |          |

\*\*\*\*\*  
 OK, \*\*\*\*\*

FIGURE (R-5); A SAMPLE OF THE FEEDBACK PRINT-OUT REPORTS TO THE ESTIMATOR

## APPENDIX (S)

PART ONE; SHOWING THE SYSTEM ENTRY FOR  
"DATA PREPARATION OPTION,  
WITH A SAMPLE OF A SELECTED  
REPORT- CALLING THROUGH THE  
SYSTEM. THE UNDERLINED TEXT  
ARE SAMPLES OF THE USER INPUT

PART TWO; SHOWING THE EIGHTEEN REPORTS  
AS SAMPLES OF "PLUS COST"  
PRINT-OUT CONTROLLING REPORTS

## PART ONE

FIGURES (1-7); SHOW THE SYSTEM ENTRY WITH  
A REPORT-CALLING EXAMPLE FOR  
ONE OF THE CONTROL REPORTS.  
THEY ALSO SHOW THE REPORTS  
PERIOD OPTIONS IN SOME OF  
THESE CONTROL REPORTS

to add to an existing contract  
to work on a new contract  
to work on building construction indices  
to work on civil Eng. construction indices  
to exit from the system

which one do you want? 1

Contract No. required to work on 1

Contract Password 1

CONTRACT NO.: 1  
PROJECT: BALFOUR BEATTY CONSTRUCTION CO'S 5111  
CLIENT: BALFOUR BEATTY CONSTRUCTION CO.  
95 MANFIELD ROAD  
LEAFSDALE  
DERBYSHIRE  
UNITED KINGDOM  
ARCHITECT/ENGINEER: HERARD WALKER  
57 BUCHANAN ROAD  
LEAFSDALE,  
DERBYSHIRE,  
UNITED KINGDOM  
TYPE OF THE WORK: BUILD

press 1 to go into the system.

press 1 to go into the system

Options:

Data Preparation ----- 1  
Requesting Indices Data ----- 2  
Labour Control ----- 3  
Plant Control ----- 4  
Material Control ----- 5  
Subcontractors Control ----- 6  
Site Expenses Control ----- 7  
On-Cost (Change Control) ----- 8  
Payroll Sheets ----- 9  
Claims ----- 10  
Variation Orders ----- 11  
Preparing Reports ----- 12  
Feather Payments ----- 13  
Exit ----- 14

which one do you want? 1

FIGURE(S-1); SYSTEM ENTRY - PREPARING REPORT SELECTION

THE REPORT OPTIONS:

=====

- Cost Monitoring Reports ----- 1
- Value Monitoring Reports ----- 2
- Cost-Value Monitoring Reports ----- 3
- Budget Cost Reports ----- 4
- Weekly BOO Costing Reports ----- 5
- Graphical Reports ----- 6
- Short Term Planning Report ----- 7
- Material Usage Reports ----- 8
- Preliminary Overall Project Report ----- 9
- Feedback Reports to The Estimator ----- 10
- Exit to The main menu ----- 11

The Required Option ? 1

COST MONITORING REPORTS:-

=====

- Weekly Cost Reports ----- 1
- Monthly Cost Reports ----- 2
- To-Date Cost Reports ----- 3
- Exit to the previous menu ----- 4

The Required Report ? 1

Required Week No. ? 1

WEEKLY COST MONITORING REPORT IN PROGRESS  
\*\*\*\* PLEASE WAIT \*\*\*\*

THE REPORT IS READY ON " FILE.1 " FILE....

Press <CR>, to go back to the previous menu..

COST MONITORING REPORTS:-

=====

- Weekly Cost Reports ----- 1
- Monthly Cost Reports ----- 2
- To-Date Cost Reports ----- 3
- Exit to the previous menu ----- 4

The Required Report ?

FIGURE (S-2) ; REQUIRED REPORT CALLING THROUGH THE SYSTEM

THE REPORT OPTIONS:-

=====

|                                          |    |
|------------------------------------------|----|
| Cost Monitoring Reports -----            | 1  |
| Value Monitoring Reports -----           | 2  |
| Cost-Value Monitoring Reports -----      | 3  |
| Budget Cost Reports -----                | 4  |
| Weekly BOB Costing Reports -----         | 5  |
| Graphical Reports -----                  | 6  |
| Short Term Planning Report -----         | 7  |
| Material Usage Reports -----             | 8  |
| Preliminary Overall Project Report ----- | 9  |
| Feedback Reports to The Estimator -----  | 10 |
| Exit to The Main Menu -----              | 11 |

The Required Option ? 2

VALUE MONITORING REPORTS:-

=====

|                                 |   |
|---------------------------------|---|
| Monthly Value Report -----      | 1 |
| To-Date Value Report -----      | 2 |
| Exit to the previous menu ----- | 3 |

The Required Report ?

FIGURE (S-3); THE REPORT OPTIONS OF VALUE MONITORING REPORT SELECTION

THE REPORT OPTIONS:-

=====

- Cost Monitoring Reports ----- 1
- Value Monitoring Reports ----- 2
- Cost-Value Monitoring Reports ----- 3
- Budget Cost Reports ----- 4
- Weekly BoO Costing Reports ----- 5
- Graphical Reports ----- 6
- Short Term Planning Report ----- 7
- Material Usage Reports ----- 8
- Preliminary Overall Project Report ----- 9
- Feedback Reports to The Estimator ----- 10
- Exit to The Main Menu ----- 11

The Required Option    ?      3  

COST-VALUE MONITORING REPORT:-

=====

- Weekly Cost-Value Report ----- 1
- Monthly Cost-Value Report ----- 2
- To-Date Cost-Value Report ----- 3
- Exit to the previous menu ----- 4

The Required Report ?

FIGURE (S-4) ; THE REPORT OPTIONS OF COST-VALUE MONITORING SELECTION



THE REPORT OPTIONS:-

=====

- Cost Monitoring Reports ----- 1
- Value Monitoring Reports ----- 2
- Cost-Value Monitoring Reports ----- 3
- Budget Cost Reports ----- 4
- Weekly BoQ Costing Reports ----- 5
- Graphical Reports ----- 6
- Short Term Planning Report ----- 7
- Material Usage Reports ----- 8
- Preliminary Overall Project Report ----- 9
- Feedback Reports to The Estimator ----- 10
- Exit to The Main Menu ----- 11

The Required Option    6

GRAPHICAL REPORTS OPTIONS:-

=====

- To-date Actual/Estimated Cost Report ----- 1
- To-date Actual Cost-Value Report ----- 2
- Exit to the previous menu ----- 3

The Required Report    2

FIGURE (S-5) ; THE REPORT OPTIONS OF GRAPHICAL REPORTS SELECTION

THE REPORT OPTIONS:-

=====

- Cost Monitoring Reports ----- 1
- Value Monitoring Reports ----- 2
- Cost-Value Monitoring Reports ----- 3
- Budget Cost Reports ----- 4
- Weekly BoQ Costing Reports ----- 5
- Graphical Reports ----- 6
- Short Term Planning Report ----- 7
- Material Usage Reports ----- 8
- Preliminary Overall Project Report ----- 9
- Feedback Reports to The Estimator ----- 10
- Exit to The Main menu ----- 11

The Required Option ? 8

MATERIAL USAGE REPORTS:-

=====

- Monthly Basis Material Wastage Report ----- 1
- Monthly Basis Material Utilization Report ----- 2
- Exit to the previous menu ----- 3

The Required Report ?

FIGURE (S-6); THE REPORT OPTIONS OF MATERIAL USAGE REPORTS SELECTION

THE REPORT OPTIONS:-

=====

|                                          |    |
|------------------------------------------|----|
| Cost Monitoring Reports -----            | 1  |
| Value Monitoring Reports -----           | 2  |
| Cost-Value Monitoring Reports -----      | 3  |
| Budget Cost Reports -----                | 4  |
| Weekly BoW Costing Reports -----         | 5  |
| Graphical Reports -----                  | 6  |
| Short Term Planning Report -----         | 7  |
| Material Usage Reports -----             | 8  |
| Preliminary Overall Project Report ----- | 9  |
| Feedback Reports to The Estimator -----  | 10 |
| Exit to The Main Menu -----              | 11 |

The Required Option    ? 9

PRELIMINARY REPORT OPTIONS:-

=====

|                                 |   |
|---------------------------------|---|
| Weekly Basis Report -----       | 1 |
| Interimly Basis Report -----    | 2 |
| Exit to the previous menu ----- | 3 |

The Required Report ?

FIGURE (S-7); THE REPORT OPTIONS OF OVERALL PROJECT PRELIMINARY REPORTS SELECTION

## PART TWO

FIGURES (8-25); SHOW THE EIGHTEEN REPORTS  
AS SAMPLES OF "PLUS COST"  
PRINT-OUT CONTROL AND  
MONITORING REPORTS

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

WEEK NO.: 1  
WEEK ENDING: 12/10/68

WEEKLY COST MONITORING STATEMENT  
\*\*\*\*\*

| COST CODE | DESCRIPTION             | THIS WEEK QUANTITY | UNIT | COST ESTIMATED ACTUAL | LABOUR           | PLANT            | MATERIAL          | SUB-CONT.       | PRELIMIN.          | INITIAL |
|-----------|-------------------------|--------------------|------|-----------------------|------------------|------------------|-------------------|-----------------|--------------------|---------|
| 1         | TEMPORARY ACCOMMODATION | 4.00               | SUM  | 871.65<br>1184.51     | 105.65<br>157.78 | 422.62<br>200.20 | 845.23<br>250.75  | 150.68<br>80.50 | 2403.53<br>1873.54 |         |
| 2         | SITE PREPARATION        | 40.00              | SUM  | 95.76<br>411.28       | 92.99<br>336.91  | 38.56<br>57.75   | 0.00<br>0.00      | 0.00<br>0.00    | 206.00<br>805.94   |         |
| 3         | PROVISIONAL SUMS        | 20.00              | SUM  | 11.00<br>136.34       | 0.00<br>0.00     | 38.50<br>165.00  | 0.00<br>0.00      | 5.50<br>18.00   | 55.00<br>312.54    |         |
| 4         | STEEL WORK              | 90.00              | M    | 3519.84<br>676.01     | 0.00<br>0.00     | 0.00<br>0.00     | 2346.56<br>601.25 | 0.00<br>0.00    | 5000.00<br>1000.00 |         |
| 6         | CONCRETING              | 30.00              | M3   | 941.04<br>140.76      | 276.78<br>47.50  | 313.68<br>0.00   | 0.00<br>0.00      | 179.16<br>55.17 | 1000.66<br>143.43  |         |
| 9         | TAKE UP AND DISPOSE     | 210.00             | LM   | 1858.97<br>1479.65    | 0.00<br>0.00     | 0.00<br>0.00     | 7435.89<br>210.00 | 0.00<br>0.00    | 9294.86<br>1509.65 |         |

===== THIS WEEK GAINS =====

13,901.19

(1K7)

FIGURE (S-8); WEEKLY COST MONITORING REPORT

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

MONTH DATE: 0000

MONTHLY COST MONITORING STATEMENT  
\*\*\*\*\*

| CODE | DESCRIPTION             | THIS MONTH QUANTITY | UNIT | COST ESTIMATED | ACTUAL  | LABOUR  | PLANT  | MATERIAL | SUB-CONT. | PRELIMIN. | INITIAL |
|------|-------------------------|---------------------|------|----------------|---------|---------|--------|----------|-----------|-----------|---------|
| 1    | TEMPORARY ACCOMMODATION | 7.00                | SUM  | 1525.38        | 1907.28 | 184.89  | 366.14 | 739.58   | 1479.15   | 0.00      | 2106.55 |
| 2    | SITE PREPAKATION        | 85.00               | SUM  | 202.42         | 640.78  | 197.60  | 857.51 | 81.94    | 0.00      | 0.00      | 1516.97 |
| 3    | PROVISIONAL SUMS        | 20.00               | SUM  | 11.00          | 136.34  | 0.00    | 0.00   | 38.50    | 0.00      | 5.50      | 481.95  |
| 4    | STEEL WORK              | 410.00              | M    | 16034.83       | 2839.25 | 0.00    | 0.00   | 0.00     | 10689.89  | 0.00      | 1556.04 |
| 6    | CONCRETING              | 160.00              | M3   | 5018.89        | 1024.76 | 1476.15 | 134.08 | 1672.96  | 0.00      | 0.00      | 55.00   |
| 9    | TAKE UP AND DISPOSE     | 210.00              | LM   | 1858.97        | 1479.65 | 0.00    | 0.00   | 0.00     | 7435.89   | 0.00      | 119.34  |

\*\*\*\*\* THIS MONTH GAINS \*\*\*\*\*

OK,

FIGURE (S-9) ; MONTHLY COST MONITORING REPORT

TO-DATE COST MONITORING REPORT  
 \*\*\*\*\*

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

TODAY DATE : 11/11/88

| COST CODE | DESCRIPTION             | TO-DATE QUANTITY | UNIT | COST      |         | LABOUR  | PLANT  | MATERIAL | SUB. CONT. | EST. TIME |
|-----------|-------------------------|------------------|------|-----------|---------|---------|--------|----------|------------|-----------|
|           |                         |                  |      | ESTIMATED | ACTUAL  |         |        |          |            |           |
| 1         | TEMPORARY ACCOMMODATION | 7.00             | SUM  | 1525.38   | 1907.28 | 184.89  | 366.14 | 739.58   | 1479.14    | 277.14    |
|           |                         |                  |      | 200.20    | 80.30   |         |        |          | 963.05     | 80.30     |
| 2         | SITE PREPARATION        | 85.00            | SUM  | 202.42    | 640.78  | 197.60  | 857.51 | 81.93    | 0.00       | 0.00      |
|           |                         |                  |      | 57.75     | 0.00    |         |        |          | 0.00       | 0.00      |
| 3         | PROVISIONAL SUMS        | 20.00            | SUM  | 11.00     | 136.34  | 0.00    | 0.00   | 38.50    | 0.00       | 5.50      |
|           |                         |                  |      | 165.00    | 792.00  |         |        |          | 792.00     | 18.00     |
| 4         | STEEL WORK              | 410.00           | M    | 16034.83  | 2839.25 | 0.00    | 0.00   | 0.00     | 10689.89   | 0.00      |
|           |                         |                  |      | 0.00      | 0.00    |         |        |          | 2383.15    | 0.00      |
| 6         | CONCRETING              | 160.00           | M3   | 5018.89   | 1024.76 | 1476.14 | 134.08 | 1672.96  | 0.00       | 618.87    |
|           |                         |                  |      | 0.00      | 0.00    |         |        |          | 641.25     | 55.17     |
| 9         | TAKE UP AND DISPOSE     | 210.00           | LM   | 1858.97   | 1479.65 | 0.00    | 0.00   | 0.00     | 2435.89    | 0.00      |
|           |                         |                  |      | 0.00      | 0.00    |         |        |          | 1002.00    | 0.00      |

=====

OK,

TO-DATE GAINS 3025.98

FIGURE (S-10); TO-DATE COST MONITORING REPORT

INTERIM VALUE MONITORING STATEMENT  
 .....

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION CQS SYSTEM

MONTH DATE: 2/88

| COST CODE | THIS VALU. QUALITY      | UNIT | VALUE     | LABOUR | PLANT  | MATERIAL | SUB-CONT. | PRELIMIN. | V.O.   | INFLATION |
|-----------|-------------------------|------|-----------|--------|--------|----------|-----------|-----------|--------|-----------|
| 1         | TEMPORARY ACCOMMODATION |      |           |        |        |          |           |           |        |           |
|           | 4.00                    | SUM  | ESTIMATED | 298.20 | 114.48 | 919.72   | 577.50    | 104.12    |        |           |
|           |                         |      | ACTUAL    | 298.20 | 114.48 | 919.72   | 577.50    | 104.12    | -27.90 | 0.00      |
| 3         | PROVISIONAL SUMS        |      |           |        |        |          |           |           |        |           |
|           | 1.00                    | SUM  | ESTIMATED | 0.00   | 225.00 | 0.00     | 0.00      | 0.00      |        |           |
|           |                         |      | ACTUAL    | 0.00   | 225.00 | 0.00     | 0.00      | 0.00      | 0.00   | 0.00      |

THIS VALUATION'S CLAIMS SUMMARY  
 .....

ACCEPTED CLAIMS  
 .....

| CLAIM NO | DESCRIPTION                 | AMOUNT |
|----------|-----------------------------|--------|
| 1        | UNFORESEEN GROUND CONDITION | 811.94 |
|          | TOTAL                       | 811.94 |

NOT YET ACCEPTED CLAIMS  
 .....

| CLAIM NO. | DESCRIPTION             | AMOUNT  |
|-----------|-------------------------|---------|
| 1         | DELAY DUE LATE DRAWINGS | 2822.33 |
|           | TOTAL                   | 2822.33 |

INTERIM VALUE MONITORING STATEMENT SUMMARY  
 .....

|                                        | AMOUNT  |
|----------------------------------------|---------|
| BID VAL. AMOUNT                        | 2465.39 |
| FROM VARIATION ORDERS                  | -27.90  |
| FROM INFLATION                         | 0.00    |
| FROM ACCEPTED CLAIMS                   | 811.94  |
| ACTUAL VALUE OF WORK DONE              | 3249.43 |
| ESTIMATED VALUE OF WORK DONE           | 2465.39 |
| DIFFERENCE                             | 784.04  |
| EXPECTED AMOUNT FROM UNACCEPTED CLAIMS | 2822.33 |
| THIS VALUATION'S GAINS IN VALUE IS     | 3606.37 |

FIGURE (S-11); INTERIM VALUE MONITORING REPORT



1 TO-DATE VALUE MONITORING STATEMENT  
 .....

1 CONTRACT NO: HALFOUR BEATTY CONSTRUCTION OPS SYSTEM

TODAY DATE: 12 3 98

| COST CODE | TODATE VL. QUALITY      | UNIT | VALUE     | LABOUR | PLANT  | MATERIAL | SUB-CONT. | PRELIMIN. | V.O.   | INFLATION |
|-----------|-------------------------|------|-----------|--------|--------|----------|-----------|-----------|--------|-----------|
| 1         | TEMPORARY ACCOMMODATION |      |           |        |        |          |           |           |        |           |
|           | 6.00                    | SUM  | ESTIMATED | 298.20 | 114.48 | 919.72   | 577.50    | 104.12    |        |           |
|           |                         |      | ACTUAL    | 298.20 | 114.48 | 919.72   | 577.50    | 104.12    | -27.90 | 0.00      |
| 3         | PROVISIONAL SUMS        |      |           |        |        |          |           |           |        |           |
|           | 1.00                    | SUM  | ESTIMATED | 0.00   | 225.00 | 0.00     | 0.00      | 0.00      |        |           |
|           |                         |      | ACTUAL    | 0.00   | 225.00 | 0.00     | 0.00      | 0.00      | 0.00   | 0.00      |

TODATE VALUATION'S CLAIMS SUMMARY  
 .....

1 ACCEPTED CLAIMS  
 .....

| CLAIM NO. | DESCRIPTION                 | AMOUNT |
|-----------|-----------------------------|--------|
| 1         | UNFORESEEN GROUND CONDITION | 811.94 |
|           | TOTAL                       | 811.94 |

1 NOT YET ACCEPTED CLAIMS  
 .....

| CLAIM NO. | DESCRIPTION             | AMOUNT  |
|-----------|-------------------------|---------|
| 1         | DELAY DUE LATE DRAWINGS | 2822.33 |
|           | TOTAL                   | 2822.33 |

TO-DATE VALUE MONITORING STATEMENT SUMMARY  
 .....

|                                        | AMOUNT  |
|----------------------------------------|---------|
| 150 VAL. AMOUNT                        | 3400.00 |
| FROM VARIATION ORDERS                  | -27.90  |
| FROM INFLATION                         | 0.00    |
| FROM ACCEPTED CLAIMS                   | 811.94  |
| ACTUAL VALUE OF WORK DONE              | 4184.04 |
| ESTIMATED VALUE OF WORK DONE           | 3400.00 |
| DIFFERENCE                             | 784.04  |
| EXPECTED AMOUNT FROM UNACCEPTED CLAIMS | 2822.33 |
| TODATE VALUATION'S GAINS IN VALUE IS   | 3406.17 |

FIGURE (S-12); TO-DATE VALUE MONITORING REPORT

CONTRACT ( 1 ) : HALFOUR BEATTY CONSTRUCTION COS SYSTEM

WEEK NO.: 1  
WEEK ENDING: 2/2/80

WEEKLY ACTUAL COST-VALUE MONITORING STATEMENT

\*\*\*\*\*

| COST CODE | THIS WEEK QUALITY       | UNIT | ACTUAL VALUE COST | LABOUR  | PLANT  | MATERIAL | SUB-COMT. | PRELIMIN. | TOTAL    |
|-----------|-------------------------|------|-------------------|---------|--------|----------|-----------|-----------|----------|
| 1         | TEMPORARY ACCOMMODATION | SUM  |                   |         |        |          |           |           |          |
|           | 4.00                    |      |                   | 898.60  | 108.92 | 435.69   | 871.37    | 163.38    | 2472.97  |
|           |                         |      |                   | 1184.51 | 157.78 | 200.20   | 250.75    | 80.30     | 1873.54  |
| 2         | SITE PREPARATION        | SUM  |                   |         |        |          |           |           |          |
|           | 40.00                   |      |                   | 95.26   | 92.99  | 38.56    | 0.00      | 0.00      | 226.81   |
|           |                         |      |                   | 411.28  | 336.91 | 57.75    | 0.00      | 0.00      | 805.94   |
| 3         | PROVISIONAL SUMS        | SUM  |                   |         |        |          |           |           |          |
|           | 20.00                   |      |                   | 11.00   | 0.00   | 38.50    | 0.00      | 5.50      | 55.00    |
|           |                         |      |                   | 136.34  | 0.00   | 165.00   | 0.00      | 18.00     | 319.34   |
| 4         | STEEL WORK              | M    |                   |         |        |          |           |           |          |
|           | 90.00                   |      |                   | 3591.67 | 0.00   | 0.00     | 2394.45   | 0.00      | 5986.12  |
|           |                         |      |                   | 676.01  | 0.00   | 0.00     | 601.25    | 0.00      | 1277.26  |
| 6         | CONCRETING              | M3   |                   |         |        |          |           |           |          |
|           | 30.00                   |      |                   | 1045.60 | 307.53 | 348.53   | 0.00      | 143.51    | 1845.18  |
|           |                         |      |                   | 140.76  | 47.50  | 0.00     | 0.00      | 55.17     | 243.43   |
| 9         | TAKE UP AND DISPOSE     | LM   |                   |         |        |          |           |           |          |
|           | 210.00                  |      |                   | 2512.13 | 0.00   | 0.00     | 10048.50  | 0.00      | 12560.63 |
|           |                         |      |                   | 1479.65 | 0.00   | 0.00     | 210.00    | 0.00      | 1689.65  |

THIS WEEK GAINS 16942.53

DK,

FIGURE(S-13) ; WEEKLY COST-VALUE MONITORING STATEMENT

1

INTERIM VALUE-COST MONITORING STATEMENT  
\*\*\*\*\*

CONTRACT ( ) : BALFOUR BEATTY CONSTRUCTION OPS SYSTEM

MONTH DATE: C A S

| POD NO. | THIS MONTH QUANTITY | UNIT | ACTUAL | LABOUR  | PLANT   | MATERIAL | SUB-CONT. | PRELIMIN. | V.O.   | INFLATION |
|---------|---------------------|------|--------|---------|---------|----------|-----------|-----------|--------|-----------|
| 1       | 7.00                | SUM  | COST   | 1907.28 | 366.14  | 200.20   | 963.05    | 80.30     |        |           |
|         |                     |      | VALUE  | 347.90  | 133.56  | 1073.01  | 673.75    | 121.47    | -27.90 | 0.00      |
| 3       | 20.00               | SUM  | COST   | 136.34  | 0.00    | 165.00   | 0.00      | 18.00     |        |           |
|         |                     |      | VALUE  | 0.00    | 4500.00 | 0.00     | 0.00      | 0.00      | 0.00   | 0.00      |

1

THIS VALUATION'S CLAIMS SUMMARY  
\*\*\*\*\*

ACCEPTED CLAIMS  
\*\*\*\*\*

| CLAIM NO. | DESCRIPTION                 | AMOUNT |
|-----------|-----------------------------|--------|
| 1         | UNFORESEEN GROUND CONDITION | 811.94 |
| TOTAL     |                             | 811.94 |

NOT YET ACCEPTED CLAIMS  
\*\*\*\*\*

| CLAIM NO. | DESCRIPTION             | AMOUNT  |
|-----------|-------------------------|---------|
| 1         | DELAY DUE LATE DRAWINGS | 2022.33 |
| TOTAL     |                         | 2022.33 |

1

INTERIM VALUE-COST MONITORING STATEMENT SUMMARY  
\*\*\*\*\*

|                           | AMOUNT  |
|---------------------------|---------|
| POD VALUATION AMOUNT      | 6849.69 |
| FROM VARIATION ORDERS     | -27.90  |
| FROM INFLATION            | 0.00    |
| FROM ACCEPTED CLAIMS      | 811.94  |
| ACTUAL VALUE OF WORK DONE | 2633.73 |
| ACTUAL COST OF WORK DONE  | 3836.31 |
| DIFFERENCE                | 3797.42 |
| FROM UNACCEPTED CLAIMS    | 2022.33 |
| THIS VALUATION'S GAINS IS | 6619.75 |

111,

FIGURE (S-14); INTERIM COST-VALUE MONITORING REPORT

TO-DATE VALUE-COST MONITORING STATEMENT

CONTRACT ( ) : BALFOUR BEATTY CONSTRUCTION CDS SYSTEM

TODAY DATE: 12/3/88

| COD NO. | TODATE QUANTITY         | UNIT | VALUE | LABOUR  | PLANT   | MATERIAL | SUB-CONT. | PRELIMIN. | V.O.   | INFLATION |
|---------|-------------------------|------|-------|---------|---------|----------|-----------|-----------|--------|-----------|
| 1       | TEMPORARY ACCOMMODATION |      |       |         |         |          |           |           |        |           |
|         | 4.00                    | SUM  | COST  | 1184.51 | 157.70  | 200.20   | 250.75    | 80.30     |        |           |
|         |                         |      | VALUE | 190.00  | 76.32   | 613.15   | 385.00    | 69.41     | -27.90 | 0.00      |
| 3       | PROVISIONAL SUMS        |      |       |         |         |          |           |           |        |           |
|         | 20.00                   | SUM  | COST  | 136.34  | 0.00    | 165.00   | 0.00      | 18.00     |        |           |
|         |                         |      | VALUE | 0.00    | 4500.00 | 0.00     | 0.00      | 0.00      | 0.00   | 0.00      |

UP TO-DATE CLAIMS SUMMARY

ACCEPTED CLAIMS

| CLAIM NO. | DESCRIPTION                 | AMOUNT |
|-----------|-----------------------------|--------|
| 1         | UNFORESEEN GROUND CONDITION | 811.94 |
|           | TOTAL                       | 811.94 |

NOT YET ACCEPTED CLAIMS

| CLAIM NO. | DESCRIPTION             | AMOUNT  |
|-----------|-------------------------|---------|
| 1         | DELAY DUE LATE DRAWINGS | 2822.33 |
|           | TOTAL                   | 2822.33 |

TO-DATE VALUE-COST MONITORING STATEMENT SUMMARY

| AMOUNT                    |         |
|---------------------------|---------|
| BOO VALUATION AMOUNT      | 5842.68 |
| FROM VARIATION ORDERS     | -27.90  |
| FROM INFLATION            | 0.00    |
| FROM ACCEPTED CLAIMS      | 811.94  |
| ACTUAL VALUE OF WORK DONE | 6626.72 |
| ACTUAL COST OF WORK DONE  | 2192.88 |
| DIFFERENCE                | 4433.84 |
| EXPECTED AMOUNT           | 2822.33 |
| THIS VALUATION'S GAINS IS | 7056.17 |

FIGURE (S-15); TO-DATE COST-VALUE MONITORING REPORT

TODATE BUDGET COST REPORT  
=====

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

TODAY DATE : 1 27 5/198

| COST CODE | TOT. VALUE OF WORK      | BUDGET VAL OF WORK | CUMULATIVE   |             |                   |                 | MONTH        |             |                   | VARIANCE (AS %) | VARIANCE (POUNDS) | VARIANCE (AS %) |
|-----------|-------------------------|--------------------|--------------|-------------|-------------------|-----------------|--------------|-------------|-------------------|-----------------|-------------------|-----------------|
|           |                         |                    | ACTUAL VALUE | ACTUAL COST | VARIANCE (POUNDS) | VARIANCE (AS %) | ACTUAL VALUE | ACTUAL COST | VARIANCE (POUNDS) |                 |                   |                 |
| 1         | TEMPORARY ACCOMMODATION | 4765.32            | 1442.00      | 3516.97     | -1249.97          | -35.54          | 1442.00      | 3516.97     | -2074.97          | -59.00          |                   |                 |
| 3         | PROVISIONAL SUMS        | 13750.00           | 5000.00      | 1111.34     | 4713.66           | 424.14          | 5000.00      | 1111.34     | 3888.66           | 19.99           |                   |                 |
|           | TOTAL                   | 18515.32           | 6442.00      | 4628.31     | 3463.69           | 74.84           | 6442.00      | 4628.31     | 1813.69           | 19.99           |                   |                 |

CLAIMS NOT CONSIDERED IN THIS REPORT

OK,

FIGURE (S-16) ; TO-DATE BUDGET COST REPORT

1 WEEKLY ACTIVITY/COST CENTER COSTING STATEMENT  
 \*\*\*\*\*

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

WEEK NO.: 1  
 WEEK ENDING: 1/27/68

| COST CODE | DESCRIPTION             | UNIT | RATE   | CUMULATIVE |           | THIS WEEK |           |
|-----------|-------------------------|------|--------|------------|-----------|-----------|-----------|
|           |                         |      |        | QUANTITY   | ACT. COST | QUANTITY  | ACT. UNIT |
| 1         | TEMPORARY ACCOMMODATION | SUM  | 680.76 | 4.00       | 1873.54   | 4.00      | 1873.54   |
| 2         | SITE PREPARATION        | SUM  | 5.67   | 40.00      | 805.94    | 40.00     | 805.94    |
| 3         | PROVISIONAL SUMS        | SUM  | 2.75   | 20.00      | 319.34    | 20.00     | 319.34    |
| 4         | STEEL WORK              | M    | 78.25  | 90.00      | 1277.26   | 90.00     | 1277.26   |
| 6         | CONCRETING              | M3   | 68.34  | 30.00      | 243.43    | 30.00     | 243.43    |
| 9         | TAKE UP AND DISPOST     | LM   | 79.25  | 210.00     | 1609.65   | 210.00    | 1609.65   |

=====

FIGURE (S-17) ; WEEKLY ACTIVITY/COST CENTER REPORT

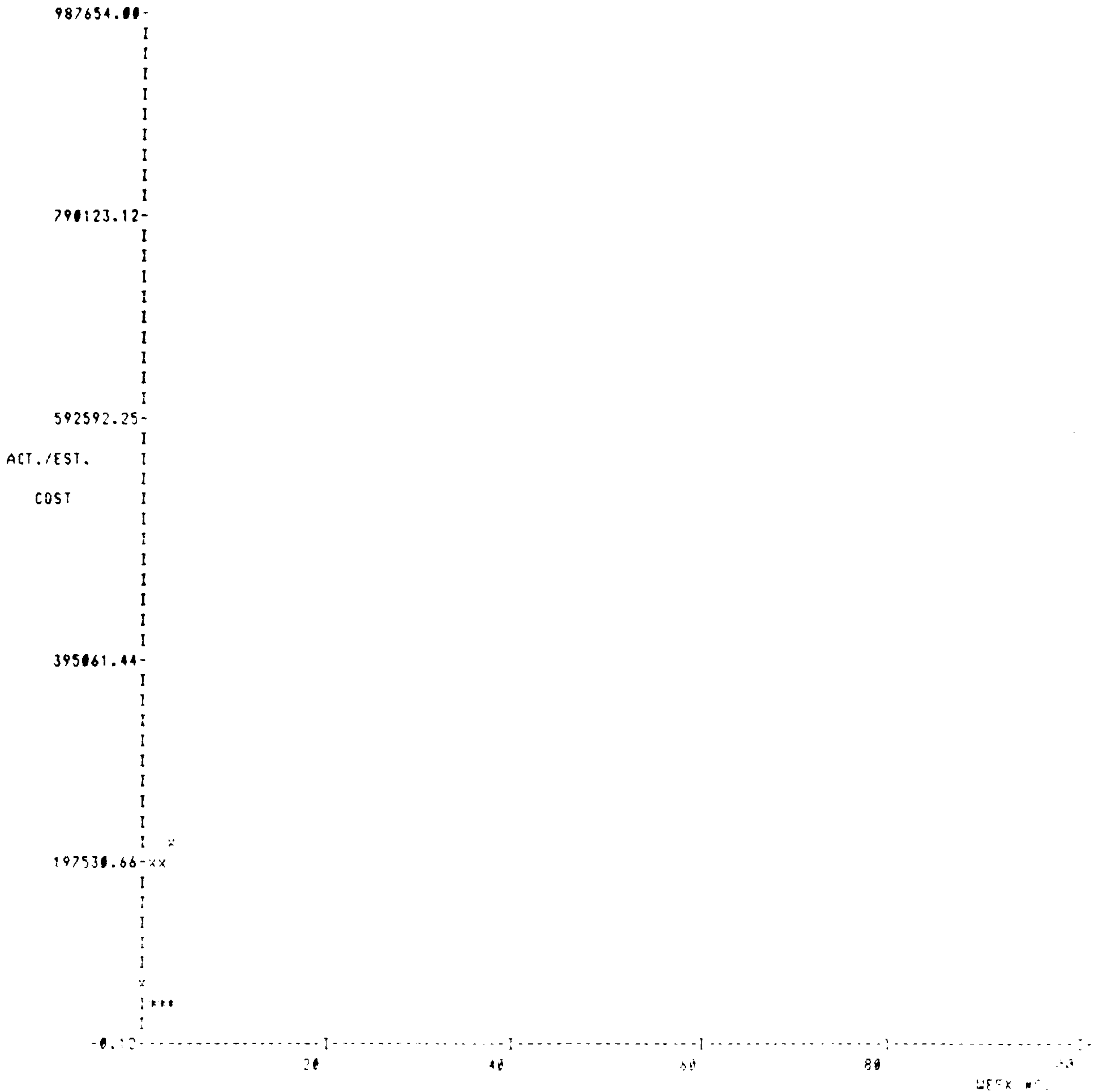
TO-DATE ACTUAL-BUDGET COST GRAPHICAL REPORT

\*\*\*\*\*

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

Today Date : 23 1 98

POUNDS



+ ACTUAL COST  
- EST. COST

PK,

FIGURE (S-18); TO-DATE BUDGET COST GRAPHICAL REPORT

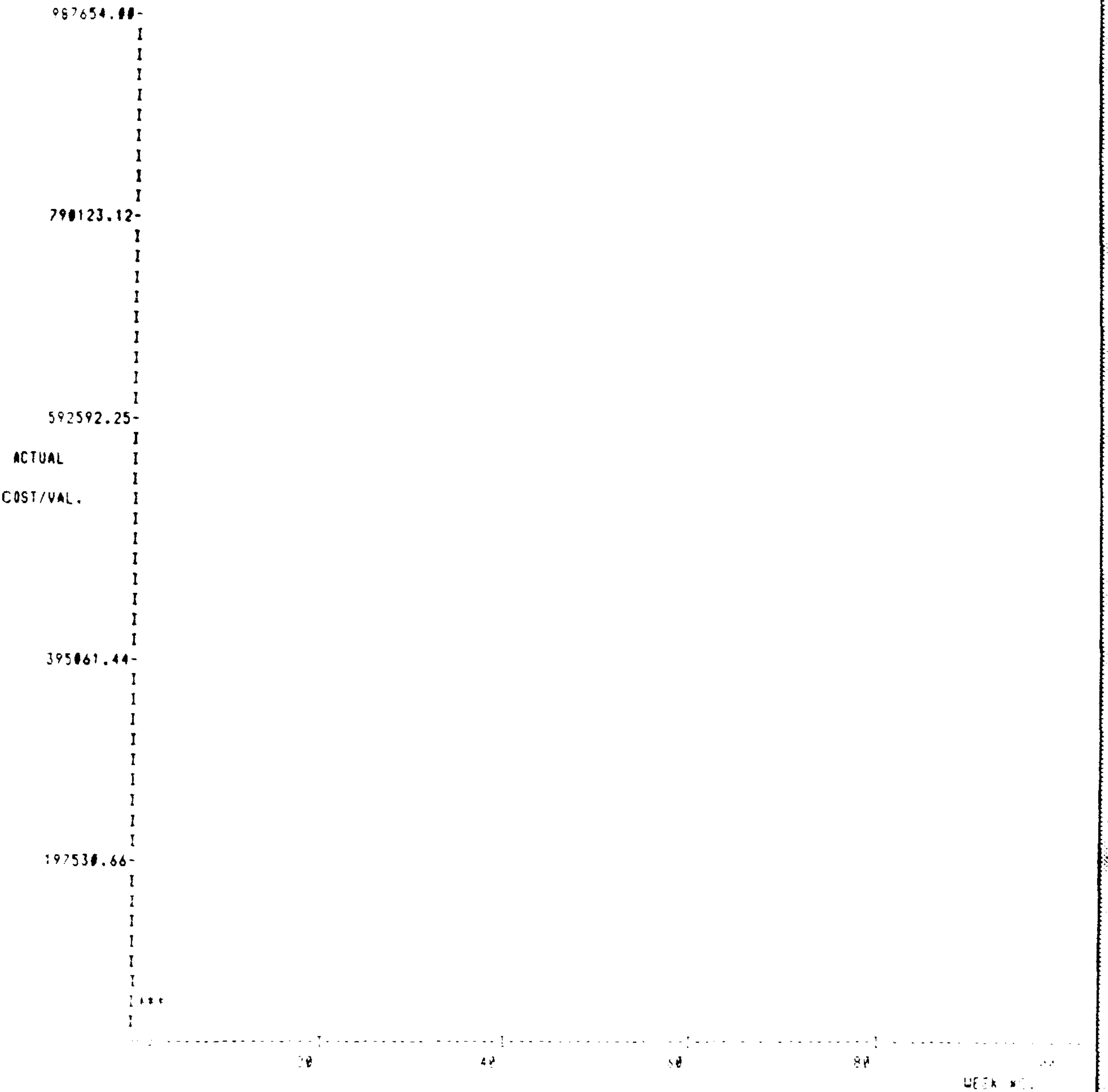
TO-DATE ACTUAL COST-VALUE GRAPHICAL REPORT

\*\*\*\*\*

CONTRACT ( 1 ) :BALFOUR BEATTY CONSTRUCTION COS SYSTEM

Today Date : 23 3 88

POUNDS



1. ACTUAL VALUE  
2. ACTUAL COST

OK,

FIGURE(S-19); TO-DATE ACTUAL COST-VALUE GRAPHICAL REPORT



SHORT TERM PLANNING AND CONTROL STATEMENT

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CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM FROM WEEK NO. : 1  
 TO WEEK NO. : 3

| COST CODE | UNIT | WORK DONE               | FIGURES | DESCRIP.  | LABOUR  | PLANT  | MATERIAL | SUBCONT. | PRELIMIN. |
|-----------|------|-------------------------|---------|-----------|---------|--------|----------|----------|-----------|
| 1         |      | TEMPORARY ACCOMMODATION |         |           |         |        |          |          |           |
|           |      | SUM                     | 7.00    | EST. VAL. | 1572.56 | 190.61 | 762.45   | 1524.90  | 285.92    |
|           |      |                         |         | FST. COST | 1575.30 | 184.89 | 739.58   | 1479.16  | 277.34    |
|           |      |                         |         | ACT. VAL. | 1572.56 | 190.61 | 762.45   | 1524.90  | 285.92    |
|           |      |                         |         | ACT. COST | 1007.28 | 366.14 | 200.20   | 742.10   | 80.30     |

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MARGIN SUMMARY

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| DESCRIPTION                | FIGURES |
|----------------------------|---------|
| VARIATION ON PLANNED VALUE | 0.00    |
| PLANNED MARGIN             | 142.96  |
| VARIATION ON PLANNED COST  | 1326.34 |
| ACTUAL MARGIN (POUNDS)     | 1469.30 |
| ACTUAL MARGIN AS (X)       | 31.79   |

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FIGURE (S-20) ; SHORT TERM PLANNING AND CONTROL REPORT

WEEKLY BASIS OVERALL PROJECT PRELIMINARY STATEMENT  
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CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

WEEK NO. : 1  
 WEEK ENDING: 2/2/88

| PRELIMINARY<br>CODE NO. | DESCRIPTION           | PRELIMINARY<br>TENDER TOT. | TENDER BUDGET    | PRELIMINARY<br>TOT. COSTED | REMARKS       |
|-------------------------|-----------------------|----------------------------|------------------|----------------------------|---------------|
| 85                      | SUPERVISION<br>HDISTS | 4,385.85<br>1,457.87       | 510.00<br>251.96 | 187.10<br>UNKNOWN          | UNDER COVERED |
| 87                      | TOWER CRANE           | 2,875.75                   | 115.00           | 65.60                      | UNDER COVERED |

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FIGURE (S-21) ; WEEKLY OVERALL PROJECT PRELIMINARY REPORT

TO-DATE OVERALL PROJECT PRELIMINARY STATEMENT  
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CONTRACT ( 1 ) : HALFOUR BEATTY CONSTRUCTION COS SYSTEM

VAL. DATE: 2/88

| PRELIMINARY<br>CODE NO. | DESCRIPTION | PRELIMINARY<br>TENDER TOT. | TENDER BUDGET | PRELIMINARY<br>TOT. COSTED | REMARKS       |
|-------------------------|-------------|----------------------------|---------------|----------------------------|---------------|
| 81                      | SUPFRVISION | 4385.85                    | 1265.25       | 187.10                     | UNDER COVERED |
| 85                      | H01STS      | 1457.87                    | 380.75        | 251.96                     | UNDER COVERED |
| 83                      | INSURANCE   | 1830.75                    | 0.00          | 0.00                       | LUMP SUM      |
| 87                      | T0UHR CRANE | 2875.75                    | 372.25        | 65.60                      | UNDER COVERED |

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FIGURE (S-22) ; TO-DATE OVERALL PROJECT PRELIMINARY REPORT

MONTHLY BASIS MATERIAL WASTAGE MONITORING STATEMENT  
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CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION COS SYSTEM

MONTH : 1988

| RES. NO. | DESCRIPTION          | UNIT | COST CODE | DELIVERED QUANTITY | MEASURED QUANTITY | UNFIXED QUANTITY | OTHER USED QUANTITY | MATERIAL IN STOCK | MATERIAL WASTG. % | ESTIMAT. WASTG. % | ALLOW. % | REMARK      |
|----------|----------------------|------|-----------|--------------------|-------------------|------------------|---------------------|-------------------|-------------------|-------------------|----------|-------------|
| 51       | SAND                 | MS   | 3         | 300.00             | 75.00             | 80.00            | 10.00               | 120.00            | 5.00              | 10.50             | 10.50    | BELOW LIMIT |
| 52       | SILT                 | MS   | 1         | 550.00             | 60.00             | 40.00            | 30.00               | 400.00            | 3.64              | 8.75              | 8.75     | BELOW LIMIT |
| 53       | CEMENT               | MS   | 2         | 450.00             | 3.00              | 20.00            | 0.00                | 400.00            | 6.00              | 5.85              | 5.85     | ABOVE LIMIT |
| 54       | MILD STEEL 12MM DIA. | MS   | 6         | 90.00              | 30.00             | 0.50             | 0.00                | 50.00             | 10.56             | 10.75             | 10.75    | BELOW LIMIT |
| 55       | MILD STEEL 16MM DIA. | MS   | 6         | 150.00             | 4.09              | 1.10             | 0.00                | 139.00            | 3.87              | 12.75             | 12.75    | BELOW LIMIT |
| 56       | MILD STEEL 10MM DIA. | MS   | 1         | 170.00             | 1.00              | 5.00             | 0.00                | 150.00            | 8.24              | 9.25              | 9.25     | BELOW LIMIT |

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FIGURE (S-23) ; MONTHLY MATERIAL WASTAGE MONITORING REPORT

MONTHLY BASIS MATERIAL UTILIZATION STATEMENT  
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CONTRACT ( 1 ): BALFOUR BEATTY CONSTRUCTION COS SYSTEM MONTH : 2/88

| RESOURCE NO. | UNIT                 | COST CODE | DELIVERED QUANTITY | MEASURED QUANTITY | QUANTITY IN STOCK | YIELD (%) | ALLOWANCE (%) | DIFFERENCE IN POUNDS | DIFFERENCE AS (%) | REMARKS |
|--------------|----------------------|-----------|--------------------|-------------------|-------------------|-----------|---------------|----------------------|-------------------|---------|
| 51           | SAND                 |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 3         | 300.00             | 75.00             | 120.00            | 2.40      | 10.75         | 22.96                | 8.35              | BAD     |
| 52           | SILT                 |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 1         | 550.00             | 60.00             | 400.00            | 2.50      | 20.74         | 52.17                | 18.24             | BAD     |
| 53           | CEMENT               |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 2         | 450.00             | 3.00              | 400.00            | 16.67     | 15.70         | 18.61                | 0.97              | WELL    |
| 54           | MILD STEEL 12MM DIA. |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 6         | 90.00              | 30.00             | 50.00             | 1.33      | 8.75          | 2479.00              | 7.40              | BAD     |
| 55           | MILD STEEL 16MM DIA. |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 6         | 150.00             | 4.00              | 139.00            | 2.69      | 15.85         | 3472.66              | 13.16             | BAD     |
| 58           | MILD STEEL 10MM DIA. |           |                    |                   |                   |           |               |                      |                   |         |
|              | M3                   | 1         | 170.00             | 1.00              | 150.00            | 20.00     | 15.75         | 878.81               | 4.25              | WELL    |

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FIGURE (S-24) ; MONTHLY MATERIAL UTILIZATION MONITORING REPORT

INTERIM FEEDBACK STATEMENT  
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VAL. DATE: 2/88

CONTRACT ( 1 ) : BALFOUR BEATTY CONSTRUCTION CRS SYSTEM

| POST CENTER ( | UNIT | QUANTITY | LABOUR | PLANT  | MATERIAL | SUBCONT. | PRELIMIN. | TOTAL RATE   | TOTAL    |
|---------------|------|----------|--------|--------|----------|----------|-----------|--------------|----------|
| 111F          | NO   | 1.00     | 207.43 | 207.43 | 207.00   | 207.00   | 207.05    | 187.46       | 1035.91  |
| 111A          | SUM  | 1.00     | 715.78 | 715.78 | 716.63   | 715.78   | 715.84    | 650.45       | 3579.81  |
| 111F          | SUM  | 1.00     | 1.00   | 1.00   | 1.00     | 1.00     | 1.00      | 0.00         | 5.00     |
| 111R          | SUM  | 1.00     | 272.03 | 271.38 | 271.58   | 271.38   | 271.44    | 246.05       | 1357.81  |
| 111C          | SUM  | 1.00     | 200.40 | 200.36 | 200.78   | 200.23   | 200.28    | 179.31       | 1002.05  |
| 111D          | SUM  | 1.00     | 826.00 | 826.00 | 826.18   | 826.70   | 826.03    | 750.75       | 4130.91  |
|               |      |          |        |        |          |          |           | BUDGET TOTAL | 11111.49 |
|               |      |          |        |        |          |          |           | COST         | 3516.97  |
|               |      |          |        |        |          |          |           | VARIANCE     | 7594.52  |

POST INCURRED

FIGURE (S-25) ; INTERIM FEEDBACK REPORT