CONSTRUCTION CONTRACT INFORMATION MANAGEMENT: AN INTEGRATED SYSTEMS APPROACH

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by

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CHAPTER NINE

THE VALUATION OF UNFIXED MATERIALS

Both the ICE and JCT Forms provide for the Contractor to be paid monies in respect of materials intended for the Contract but not yet incorporated into the works (sub-clauses 60 (1) (b) and (c) of the ICE Conditions and sub-clauses 30.2.1.2 and .3 of the JCT Forms). From consultations with the industry and a literature survey undertaken as part of the Systems Investigation and Analysis phase it was found that valuation of such materials, termed unfixed Materials, is very often an integral part of the Contractor's general materials control procedures.

This chapter describes the procedures usually adopted for controlling materials and methods of determining payments for Unfixed Materials.

9.1 THE IMPORTANCE OF MATERIALS CONTROL

According to Johnston (152) it is an open secret that large quantities of building materials are wasted every year in the United Kingdom. He attributes the waste to inadequate controls on site. In 1976 the Building Research Establishment reported that 10 - 20% of all materials delivered to site either ended up as waste or were illegally removed during the contract (159). Johnston (152) deplores this statistic on the grounds that it implies a loss, either directly or indirectly, to the whole economy the client, the Contractor, operatives and even future generations.

An analysis of the effect of reductions on the wastage of materials on company profit is most interesting. The analysis of Chadwick (158) based on 1978/79 figures is summarised below:

Table 9.1: Cost profile of the construction industry

	Materials Costs %	Labour Costs %	Overheads Costs %	Profit %
Construction industry	51	29	13	7

Table 9.2: Effect on profits of cutting costs

	Materials Costs	Labour Costs	Overheads
	% Increase in profit	% Increase in profit	% Increase in profit
Construction industry	2% cut 14.6 5% cut 36.4	2% cut 8.3 5% cut 20.7	2% cut 3.7 5% cut 9.3

Table 9.3: Cost reduction required to increase return on captial employed by 18.3%

	Return on capital employed	% Reduction Required		
		Materials Costs	Labour Costs	Overheads Costs
	%	%	%	%
Construct-ion industry	18.3	7.51	13.21	29.46

The cost profile on the construction industry (Table 9.1) indicates just how important materials costs are to the industry. Tables 9.2 and 9.3 show materials management is one area in which substantial savings could be made and profitability increased. It can be seen that a small percentage cut in materials costs could bring about a sizeable increase in profits. For instance, cutting costs of materials by 2% increases profits by 14.6%, almost double what could be achieved by a 2% cut in labour costs and four times the increase which could accrue if overheads were cut by 2%.

Table 9.3 contains even more interesting answers to the question: by how much must costs be reduced to increase the return on capital employed by 18.3%?

9.2 CONTROL OF MATERIALS' COSTS

Four factors which influence the ultimate cost of the materials element of a project and which are within some measure of control by the Contractor have been identified. They are (151, 152, 153):

* quantity to be bought,
* source of material,
* prices in orders,
* losses and wastage.

9.2.1 THE INFLUENCE OF QUANTITY

According to Johnson (152), and Bailey and Farmer (151) generally the unit prices of materials tend to decrease with increasing quantities bought.

The quantity desired for a construction project may be determined as part of estimating procedures at tender. For instance, INTEREST produces quantities of materials required through its Resource Reconciliation facility (46, 123). As the project is being executed these quantities need to be revised to take into account any variations to the works.

The quantity ordered is not necessarily the same as the quantity required for according to Bailey and Farmer (151) the quantity ordered depends on company ordering policy. Two aspects to an ordering policy may be identified. Scheduling of orders and Centralization/Decentralization.

9.2.1.1 SCHEDULING OF ORDERS

In a construction project it is unusual for the total content of any particular material to be required at once. The usual situation is for certain amounts of the total to be required every week or at various stages in the programme. One ordering policy would buy the whole lot at once. The advantages of such a policy are (151):

(i) it might be a cheaper option if purchase price is rising steeply;

(ii) it would ensure availability of scarce materials;

(iii) resolution of administrative effort and paperwork associated with ordering, expediting, receiving and paying for the materials.

The disadvantages (151) include:

(i) relatively large initial outlay of funds;

(ii) large stocks demand space;

(iii) greater risks of loss, theft and deterioration.

At the other extreme, the policy of placing separate orders according to the requirement pattern could be adopted. PLUS VAL allocates each Bill item to an activity. As PLUS VAL contains the material build-up of each item it should be possible to obtain the requirement profile of each item of material by linking it to a suitable planning package. Where such a planning package can be updated interactively it should be possible to update requirement profiles automatically.

The advantages of ordering materials according to need include (151):

(i) it would be cheaper if prices are falling;

(ii) it allows for flexibility;

(iii) reduced working capital requirements .

According to Baily and Falmer (151) many other policies are adopted apart from these two extremes and that it is common for buyers to quantify the advantages and disadvantages of various order quantities and to calculate the size of orders which gives the least-cost result.

9.2.1.2 CENTRALIZATION/DECENTRALIZATION

A construction company which has several on-going contracts has three alternative ways of procuring materials for the various contracts:-

(i) complete centralization, all buying being done by the Head Office or branch office,

(ii) complete decentralization,

(iii) a combination of centralization and decentralization.

The advantages cited for decentralizing buying are:

(i) local merchants will tend to give better service on emergency requirements if major purchases are made locally (153);

(ii) relationships in local communities where jobs are located are improved (153);

(iii) the local buyer will have a better knowledge of the needs of local suppliers, and transport and storage facilities (151);

(iv) the local buyers direct responsibility to his immediate local management will produce better control by local top management (151).

Complete centralization, on the other hand, has advantages which include:

(i) there may be price advantages in bulk purchasing (151, 153);

(ii) when shortages develop, suppliers give preference to long-term large-volume customers (153);

(iii) Centralized purchasing is more able to transfer surpluses on one contract to another where they are required (153);

(iv) Kickbacks and related irregularities are reduced (153);

(v) avoidance of price anomalies between contracts and of competition between them for materials in short supply (151);

(vi) economies of staffing and clerical effort together with uniformity in procedures, forms, standards (151).

It can be observed that generally, the advantages of one approach are the disadvantages of the other. Baily and Farmer (151) write that a combination of both is often used to obtain the benefit from the best features of each, while avoiding the disadvantages of both approaches.

9.2.2 SOURCES OF MATERIALS

Sourcing refers to how the buyer selects the sources from which to buy his material requirements. According to England (154) selection of sources of supply is the most important of the buyer's responsibilities and very often the question of quantity to buy cannot be answered before considering the source of supply. Baily and Farmer (151) recommend that for its proper performance, sourcing should be based on a continuing process of researching the supply market.

England (154) writes that buyers have attempted to establish formal vendor rating procedures as an aid in selecting suppliers. One common method of rating involves keeping records of performance under a number of headings: quality, delivery, service and price (151).

9.2.3 RECORDS OF SUPPLIERS

It was found from the procedures involved in buying that a record of a supplier should contain the following details:

(i) business name,

(ii) address,

(iii) telephone number,

(iv) Contact person,

(v) Vendor rating.

9.2.4 PRICES IN ORDERS

According to Johnston (152) the orders actually placed when a tender is successful are usually based on the quotations received during tendering. Where the prices assumed in the estimate are different from the prices at which the materials are actually bought the contractor stands to make a gain or a loss due to the nett total of such differences. These differences are referred to as buying margins (160).

Gobourne (160) maintains that there is a need to separate the contribution of buying margins so that the actual performance of plant and of labour and the effect of wastage of materials can be assessed without any distortion. Buying margins are usually contained in a Buying Margins Report, a sample of which is shown in Figure 9.1.

9.2.5 LOSSES AND WASTAGE

Waste occurs on site for a number of reasons, most of which can be prevented. Some of those enumerated by Johnston (152) are:

MATERIAL	TENDER UNIT PRICE	ACTUAL UNIT PRICE	GAIN PER UNIT	TOTAL GAIN	LOSS PER UNIT	TOTAL LOSS
2000 tonnes roadstone	15.00	14.50	0.50	1000.00	-	-
2500 tonnes cement	60.00	61.00			1.00	2 500.00
5000 tonnes aggregates	10.00	8.50	1.50	7500.00	-	-
				37533.00		8 596.00
				8596.00		
OVERALL BUYING MARGIN =				28 937.00		

Figure 9.1: A Typical Materials Buying Margins Report - After Gobourne (160).

* misinterpretation of drawings,
* overestimating the quantity required,
* faulty workmanship,
* careless handling,
* uneconomic design.

Allowances for wastage are usually made in the estimate by making percentage additions to the quantities of materials strictly necessary (123, 162). Johnston (152) claims that allowances are predominantly based on guesswork and that site accounting systems do not provide sufficient feedback of actual wastage factors.

Pilcher (156) and Gobourne (160) write that it is unnecessary to carry out variance analysis on the materials component as part of cost control in the same manner as on plant and labour costs. Cooke and Jepson (155) write that as the manner in which bulk materials are actually utilized is hardly subject to control, the allocation of their costs to cost centres would involve an exercise in apportionment that may be somewhat subjective. Generally they recommend controls based on determining wastages.

Determining waste would involve the following tasks:

XYZ CONSTRUCTION LTD CONTRACT

MATERIAL USAGE REPORT

MATERIAL	UNIT	TOTAL ACCOUNTED FOR	TOTAL DELIVERED	STOCK	GAIN	LOSS
ROADSTONE	TONNE	1100	2000	800	-	100(5%)
CEMENT	TONNE	2300	2500	400	200(8%)	-
AGGREGATES	TONNE	4900	5000	-	-	100(2%)
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
:	:	:	:	:	:	:
150mm dia. pipes	m	210	270	40	-	30(11%)

Figure 9.2: A Typical Format of A Materials Usage Report

(i) The determination of the quantities which should have been used had the assumed usage rates been achieved. For any item of material this can be done by multiplying the quantities of all bill items in which it occurs by the appropriate usage rate and summing.

(ii) The determination of the quantities of materials actually used: For any particular material this involves subtracting quantity remaining from the quantity delivered. As discussed in Section 9.4, the quantity left may also constitute unfixed materials for interim valuations and this fact is a possible link between valuations and the control of materials. It can be seen therefore that where the quantities left are measured for either the purpose of placing new orders, costing, or valuations, the task can be done once if the three tasks are being carried out at about the same time.

(iii) The difference between the results in (i) and (ii) is the saving/loss.

The gains or losses described above are usually contained in a Materials Usage Report (160). A sample of such a report is illustrated in Figure 9.2.

9.3 STEPS OF PROCUREMENT

England (154) recommends the following essential steps for the procurement of materials:

* ascertainment of the need;
* an accurate statement of the character and amount of the article;
* transmission of the purchase requisition;
* negotiation of possible sources of supply;
* vendors selection and placing of order;
* the follow-up on the order;
* the checking of the invoice;
* the delivery of the goods;
* the completion of the record.

The steps which have direct bearing on PLUS VAL are discussed below:

9.3.1 SOURCES OF SUPPLY

Deciding on a suitable source of supply may involve looking up addresses, telephone numbers, contact persons and past performance of suppliers. The storage and retrieval of such records are facilities that computers are particularly good at providing (3). INTEREST provide access to these details of supplies as well as to the quotations (46,123).

Thus, instead of rummaging through files to find quotations and comparing them it should be possible to produce a computer output of desirable suppliers based on defined criteria such as quantity, price,and performance.

9.3.2 PURCHASE ORDERS

Once the decision has been made to make a purchase, its details must be communicated to the selected supplier. Coombs and Palmer (153) note that such communication may be as informal as making a telephone call but they advise the use of purchase orders. They warn that as purchase orders are contracts,legal advice should be sought when designing such forms.

Though the format of purchase orders differs the essential requirements include (151, 163):-

(i) A title such a 'Purchase Order'. The name and address, telephone and telex numbers of the buying company;

(ii) a space for the name and address of the seller;

(iii) a serial number and a request that this number be quoted on all subsequent documents, advise notes and invoices;

(iv) date of raising orders;

(v) code number or reference number of material required;

(vi) description of material;

(vii) quantity of material;

(viii) unit of measurement;

(ix) unit price;

(x) delivery instruction (e.g. date);

(xi) discount if any;

(xii) signature of buyer;

(xiii) reference to any standard conditions of purchase.

According to Bailey and Falmer (151) the purchase order is printed in sets and usually on different coloured paper. Potential recipients of copies in the construction industry include:

* supplier,
* accounts,
* purchasing management,
* general stores,
* site management,
* site stores.

The accounts department needs the purchase order to compare against invoices from the supplier (163). Purchasing management may need them in deciding where to place any further orders and also for the purpose of expediting which is explained in Section 9.3.3. Site management needs to be notified of orders in order to vary the sequence of work in situations where deliveries are likely to be delayed (152). Purchase orders allow stores personnel to ensure that what is delivered is what is ordered (151, 163).

Where orders are held on computer files all the parties authorized to see them can have quick access without any tedious paperwork. The technology is even available to transmit the purchase orders to suppliers electronically (164).

9.3.3 EXPEDITING

Expediting is the job of following up the purchases to see that the items ordered are delivered, and that delivery is made at the place and time required by the contractor's operations (153). The details that expediters may need to carry out their jobs properly include:

* material needs of the site in terms of quantity and time,
* orders placed,
* deliveries already made,
* invoices sent,
* payment made.

Where all these details are held on computer files to which the expediter is allowed access, his job may be improved in terms of reduced effort and time required in chasing after information from their source of origin.

9.3.4 DELIVERIES

According to Coombs and Palmer (153) receiving procedures vary with what is being received, where it is being received, and for what purpose but that the typical minimum receiving procedure would involve these steps:

* unloading the materials or supplies at the job,
* counting them to see how many are there (or how much),
* inspecting them for conditions and noting any damaged items,
* checking the delivery receipt to see that it corresponds with materials being delivered,
* verification that the items received meet the type, specification, or characteristics detailed in the purchase order.

Here again there is a potential for improving performance by allowing the delivery clerk to have access to purchase orders and specifications held on computer files. The delivery clerk may in turn provide data to others by recording details of deliveries on computer files. Measurement engineers need to know quantities of materials delivered to determine monies to claim for unfixed materials. Expediters need quantities outstanding from suppliers to follow up. Site Management need quantities available for programming and scheduling. Finally, the accounts department needs the details of deliveries to check invoices and to make payments.

9.3.5 INVOICES AND DISBURSEMENT CONTROL

The accounts department must make sure that it does not pay for anything that has not been ordered or that has not been received and it must avoid making payment twice for the same goods (153). Coombs and Palmer (153) write that in one way or another the accounts department should have:

* evidence that the materials were properly ordered
* evidence of receipt of ordered goods
* evidence that the prices and discounts are correct
* evidence of authority to make disbursement.

The documents which are necessary to obtain all the above information are purchase orders, invoices and delivery notes. Here too storing the information on computer files and making them available to the accounts department will provide for better communication and perhaps better performance. Indeed all the procedures after recording of delivery notes up to writing out cheques can be automated by existing computer technology.

9.4 UNFIXED MATERIALS AND INTERIM VALUATIONS

Materials intended for the works but not yet incorporated into them fall into two classes:

(i) those delivered to the site: they are usually referred to as materials on site and by clause 53(2) of the ICE conditions, they are deemed to become the property of the Employer once they are delivered to the site. Under clause 16.1 of the JCT they only become the property of the Employer after they have been included in interim valuations.

(ii) those not yet delivered to the site but ownership in them has been transferred to the Employer (Clause 16.3 of the JCT Form and clause 54(1) of the ICE Conditions): Examples include goods of mechanical and electrical installations and temporary works stored in the Contractor's yard.

In this respect all the materials are referred to collectively as unfixed materials. The main intentions for allowing for unfixed materials to be included in interim valuations include:

(i) Contractors expend large sums of money for materials to be incorporated into the works later. Payments for such materials reduces the Contractor's capital locked up. This benefit may pass to the Employer as lower

tender prices because of reduced financing costs (153).

(ii) The contractor is enabled to purchase adequate materials at the appropriate time to meet his construction schedule. This benefit is particularly important where the materials have long delivery times. This benefit may be passed to the Employer as a project finished on schedule (133).

(iii) Where the contractor goes into bankruptcy or liquidation the Employer or his substitute contractor can step into the shoes of the former contractor with less disruption if there are materials available to proceed immediately (133).

(iv) Where the Employer is prepared to pay for substantial quantities the Contractor can buy in bulk and take advantage of discounts for their mutual benefit (153).

9.4.1 CONTRACTUAL PROVISIONS

The JCT and ICE Contracts make similar provisions on unfixed materials. However there are some differences.

9.4.1.1 THE ICE CONDITIONS

The provisions for the payment of unfixed materials are contained in Clause 53,54 and 60. By clause 53(2) all goods and materials owned by the Contractor or by any company in which the Contractor has a controlling interest become the property of the Employer after their delivery to the site. In respect of such materials the Engineer is empowered to include a discretionary percentage of their value in interim payments, which percentage is not to exceed the value inserted by the Contractor in the Appendix to the Form of Tender (Clause 60(3)(b)).

Clauses 54 and 60 empower the Engineer to include in interim payment a similar percentage of the value of unfixed materials which have not yet been delivered to site and which satisfy the following conditions:

(i) they are listed in the Appendix to the Form of Tender;

(ii) they are substantially ready for the works;

(iii) ownership in them has absolutely passed to the Employer;

(iv) they are marked as destined for the works;

(v) all necessary insurances have been taken against their loss or damage.

9.4.1.2 THE JCT 80 FORM

Provisions for interim payment in respect of unfixed materials are contained in Clauses 16, 30.2, 30.3 and 30.4. They are substantially the same as under the ICE conditions. The main differences are:

(i) with the JCT form, amounts in respect of unfixed materials are subject to retention;

(ii) under the JCT contract, materials delivered during the seven days prior to the valuation day may be excluded from the valuation.

9.4.2 MEASUREMENT OF UNFIXED MATERIALS

Four ways of measuring unfixed materials for the purpose of interim external valuation have been identified:

(a) Detailed Measurement by Physical Inspection. With this method the measurement team trudge around the site and physically inspect and take inventory of all materials awaiting incorporation into the works (157). According to Barrett this is the safest method but that it suffers from the drawback that it takes time and effort. Marks *et al* (145) advise that it is helpful if the Contractor's staff prepare a list of all materials with their respective quantities immediately prior to the valuation date. The Engineer's measurement team will then have only to check that the materials are on site and that quantities and prices are as stated. If the list is found unsatisfactory it is amended accordingly.

(b) Detailed Measurement From Accounting Records

A schedule is prepared from the usual on-site accounting records (quantities delivered less quantities used up). According to Johnston (152) this method is more accurate than physical inspection but that there is always the possibility that the quantities of materials so obtained will exceed the quantities required for the remaining work. This is also dangerous to the Employer because waste, pilfering and inadequate storage cannot be detected. It will however boost the Contractor's cashflow. In addition if careful analysis is not carried out any extra payment would lead to profits being overstated.

(c) Detailed Measurement From Accounting Records and External Valuation

With this method the Contractor's delivery records are examined and those quantities of materials which the external valuation indicates have been built into the works are deducted (157). With this method too the main dangers are:

(i) more materials than needed for the remaining works may be paid for,

(ii) waste, pilfering and inadequate storage are not detectable.

(d) Approximate Physical Measurement

This method was obtained from staff of J. Walkerdine Ltd who came to see PLUS VAL. It involves a priced inventory of the major items of materials and the addition of a round lump sum for miscellaneous items. A variation of the method would involve making the inventory from site accounting records.

9.4.3 PAYMENT CHECKS

The main problems with paying for unfixed materials from the Employer's standpoint are twofold (133):

(a) The Employer may be paying for materials ownership of which never did vest in the Contractor in the first place. In that case no matter the terms of contract the Contractor cannot effectively transfer title in the goods to the Employer as demanded by the conditions. Holding companies of the Contractor or of Supplier's may still have lien in the materials after the Employer has paid for them. If the Contractor's employment is subsequently determined for whatever reasons the materials could be claimed back by their legal owners. In the case of *Dawber Williamson Roofing Ltd v Humberside County Council* (210) sub-contractors were held entitled to remove roofing slates for which the insolvent Main Contractor had received payment because ownership in the slates had not passed from the sub-contractor to the Main Contractor.

The main danger is therefore that unless proper checks on ownership are carried before payment the, Employer may find himself paying twice for the same materials.

(b) In case of materials paid for before they are delivered to the site the situation is fraught with problems if the Contractor goes bankrupt after having received payment for them. The problems arise from the 'reputed ownership' provisions in the bankruptcy legislations (211). This provides that any property which a bankrupt at the time of his bankruptcy has, with the true owner's consent, in his possession, order, disposition under such circumstances that he is the reputed owner thereof, i.e. a bystander not knowing the actual facts would necessarily assume him to be the owner, may be taken by the bankruptcy trustees and used to pay the bankrupt's creditors though, in fact, the property belongs to someone else. This provision is intended to prevent credit being obtained on the faith of the apparent ownership of goods that do not actually belong to the debtor and which, but for this rule, his creditors could not touch (133). Due to potential pitfalls the staff of the Engineer/Architect will usually require a variety of documented evidence that adequate precautions have been taken to safeguard the Employer's interest. The checks usually made include:-

* that the materials are in accordance with the specification,
* that unfixed materials off-site are substantially ready for incorporation into the works,
* that the materials have not been brought to the site prematurely,
* that the supply contracts between the Contractor and his suppliers do not place emcumbrances on the Employer's ultimate ownership of the materials,
* that the quantities are not in excess of requirements,
* that the materials are properly stored and insured,
* inspection of invoices,
* that there are no errors in the calculation of the amount being claimed,
* that title in the goods has clearly passed to the Employer.

CHAPTER TEN

THE VALUATION OF PRELIMINARIES, SUB-CONTRACTED WORK AND PROVISIONAL SUMS

Preliminaries cover the Contractor's site overheads expenses which are usually incurred on items of an organisational and general nature and which are not restricted to any particular work section (29).

These are few, if any, construction contracts on which some part of the work is not done by a sub-contractor. Sometimes, on larger contracts, the larger sub-contractors may sub-contract portions of their own work. This practice may often lead to the creation of several 'tiers' of sub-contractors.

Generally provisional sums are monies provided in a Bill of Quantities for work or for costs which cannot be entirely foreseen or detailed at the time the tender documents are issued (28,120).

This Chapter describes the work, goods and services involved in preliminaries, sub-contracted work and provisional sums and also provides details of how they may be included in valuations. The Chapter is divided into the following parts:

* a description of the nature of preliminaries,
* a discussion of the principles and procedures involved in the valuation of preliminaries,
* a review of the practice and implications of sub-contracting,

* a review of the principles and methods of valuing sub-contracted work,
* a description of the approach to the control of sub-contracted work,
* a description of the use of provisional sums and of how the work, goods and services for which they are provided are dealt with during valuations.

10.1 PRELIMINARIES

Though in both civil engineering and building contracts most items of preliminaries relate to the Contractor's organisation and methods of construction, the stipulations of SMM6 on their measurement are different from those of the CESMM.

10.1.1 BUILDING CONTRACT PRELIMINARIES

In building contracts preliminaries are to be grouped into a separate bill called the 'Preliminaries Bill' or simply 'Preliminaries' (120).

Gray (137), analysing estimates of two building contractors over 45 contracts priced in 1980, found that they normally priced the 16 items of preliminaries as shown in Table 10.1 and that 90% of all the Preliminaries Bill is contained in only 6 of these items.

TABLE 10.1: TYPICAL PRELIMINARIES

Preliminary		% of Total Preliminaries
(1)	Staff	28.6
(2)	Plant	20.8
(3)	Scaffolding	16.8
(4)	Site Accommodation	11.8
(5)	Electrics and Power	7.0
(6)	Cleaning	5.2
(7)	Hoarding	2.0
(8)	Watching and Security	1.7
(9)	Telephone	1.3
(10)	Temporary Works	1.6
(11)	Water	0.5
(12)	Drying Out	0.3
(13)	Protection	0.4
(14)	Testing	0.3
(15)	Insurance	1.5
(16)	Frost Precautions	0.1

10.1.2 CIVIL ENGINEERING CONTRACT PRELIMINARIES

Though preliminaries in civil engineering cover substantially the same work, goods and services as in building contracts, Barnes (29) writes that it is in the area of preliminaries that the Bills of Quantities of the two types of contracts are most radically different. The main differences stem from the fact that the CESMM makes specific recommendations as to the presentation of preliminaries in Bills of Quantities whilst the SMM6 does not go to such details.

Under Section 7 of the CESMM tenderers have the option to define a group of Bill items and insert charges against them to cover expected costs which are not proportional to the quantities of the permanent work but are related to the Contractor's organisation and work methods. Such charges, referred to as Method-Related Charges (MRC's), are to be contained in the 'General Items' section of the Bill of Quantities and are usually predominantly the Contractor's preliminaries.

The CESMM provides for two types of MRC's:

* Time-Related Charges (TRC) which are of a recurrent nature and cover such activities as maintaining site facilities or operating major plant;

* Fixed Charges (FC) which are non-recurrent and cover such items as setting up, haulage of plant to and from the site and removal costs at the end of the contract.

Barnes (29) identifies the following advantages of using MRC's:

(i) The matching of the sub-division of the total value to the sub-division of the Contractor's anticipated total cost of the work ensures that interim valuations relate uniformly to the expected costs during construction. This means that there is a stable cashflow with the attendant benefits to both parties.

(ii) The effects of variations are more observable.

(iii) Some variations may not entail rate-fixing.

(iv) Payment for varied work is more likely to be reasonable and applicable.

10.2 THE VALUATION OF PRELIMINARIES

The importance of recovering sufficient payment in respect of contract preliminaries cannot be over-emphasized for Seeley (140) writes that they can sometimes account for 20% of the Contract Sum. Barrett (157) also maintains that the control of preliminaries expenditure and revenue is of particular importance to accurate financial reporting on a contract.

The valuation of preliminaries has been treated in most of the published literature in the context of building contracts. However some of the concepts and principles which are discussed below are also applicable to civil engineering contracts.

10.2.1 THE VALUATION OF BUILDING CONTRACT PRELIMINARIES

The valuation of preliminaries tends to be a problem. Barrett (157) attributes many of the difficulties to the way in which contractors price this section of the Bill of Quantities. He identifies two main approaches to estimating for preliminaries:

* The preliminaries are priced totally in the Preliminaries Bill.
* The preliminaries are priced totally or partially in rates for main work.

10.2.1.1 VALUATIONS USING A TOTALLY ISOLATED PRELIMINARIES BILL

Four main approaches have been identified from the literature and consultations with contractors:

* valuations of individual items of preliminaries,
* valuations of grouped preliminaries,
* valuations against a Preliminaries Budget,
* valuations from costs incurred by the Contractor.

10.2.1.1.1 INDIVIDUAL ITEMS OF PRELIMINARIES

Ramus (146) distinguishes four main types of items in a Preliminaries Bill:

* time-related preliminaries,
* cost-related preliminaries,
* single-payment preliminaries,
* a combination of the above (Composite items).

Those which are cost-related depend for their value on that of the remainder of the Contract Sum or its labour content. Examples of cost-related items are insurances and water for the works. Time-related preliminaries concern items the costs of which are proportional to the proportion of the Contract Period which has elapsed. Examples of time-related preliminaries include items for equipment rentals, site supervision and maintenance of site accommodation. Single-payment items are those the values of which are not affected either by the value of the rest of the contract or by the Contract Period but cover expenses incurred at particular points in the progress of the work. An example is the provision of temporary roads. Some preliminaries consist of one or more single-payment components and a time-related one. Examples are the provision of some heavy plant which involves fixed charges for their setting up and removal costs and periodic charges for rentals, operation and maintenance costs.

(A) TIME-RELATED ITEMS

If the contract amount for an item is spread uniformly over the Contract Period, the amount of the item to be included in a valuation is given by the formula:

$$V = \frac{T}{D} \times A \quad \text{.................... Equation (1)}$$

where

V = amount to be included in the valuation,

T = the time elapsed since the start of the item,

D = the duration of the item,

A = Bill amount

The equation follows from the definition of a time-related item.

According to Ramus (146) the main objection to this method is that it can sometimes lead to overpayment of some items and underpayment of others. Overpayment will occur when the Contract is behind schedule and this can be very significant where the rate-loading of such items had been done. Underpayment takes place where the progress of the Contract is ahead of program.

Barnes (29) proposes a method of dealing with situations where the actual progress is different from the programmed progress. His solution is based on the Architect or Engineer reassessing the actual duration and applying it in place of the programmed duration D in Equation (1).

The following example illustrates the proposal: An operation is covered in the Bill of Quantities by a time-related charge of £12,000. The program submitted shows that it is expected to take 10 months. At the end of 3 months of carrying out the operation, if the operation is progressing according to schedule £3,000 representing 3/10 of the charge would be certified. However, if because progress is ahead of schedule and the Contractor is expected to complete the operation in another 5 months, £4,500 representing 3/8 of the charge would be certified. If on the other hand the operation is behind schedule and is expected to be completed in another 9 months £3,000 representing 3/12 of the charge is certified.

(B) COST-RELATED ITEMS

The amount to be included in a valuation is given by the formula:

$$V = \frac{A}{C_s} \times W \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{Equation (2)}$$

where

V = amount to be included in valuations

A = Bill amount of item

C_s = Contract sum less preliminaries and Prime Cost items

W = Value of all work executed less values for preliminaries and Prime Cost sums.

The formula follows from the definition of a cost-related item in Section 10.2.1.1.1.

The main problem with using the method is that there is a danger of inadvertently exceeding the total value of the item when the total value of the Contractor's own work has been significantly increased by variations (146). Where the effect of variations is to decrease the total value of the Contractor's own work the value of the operation would still be under-recovered at completion.

Where the total value of the contractor's own work has changed from its tender amount the approach to adopt is as illustrated in Figures 10.1 and 10.2.

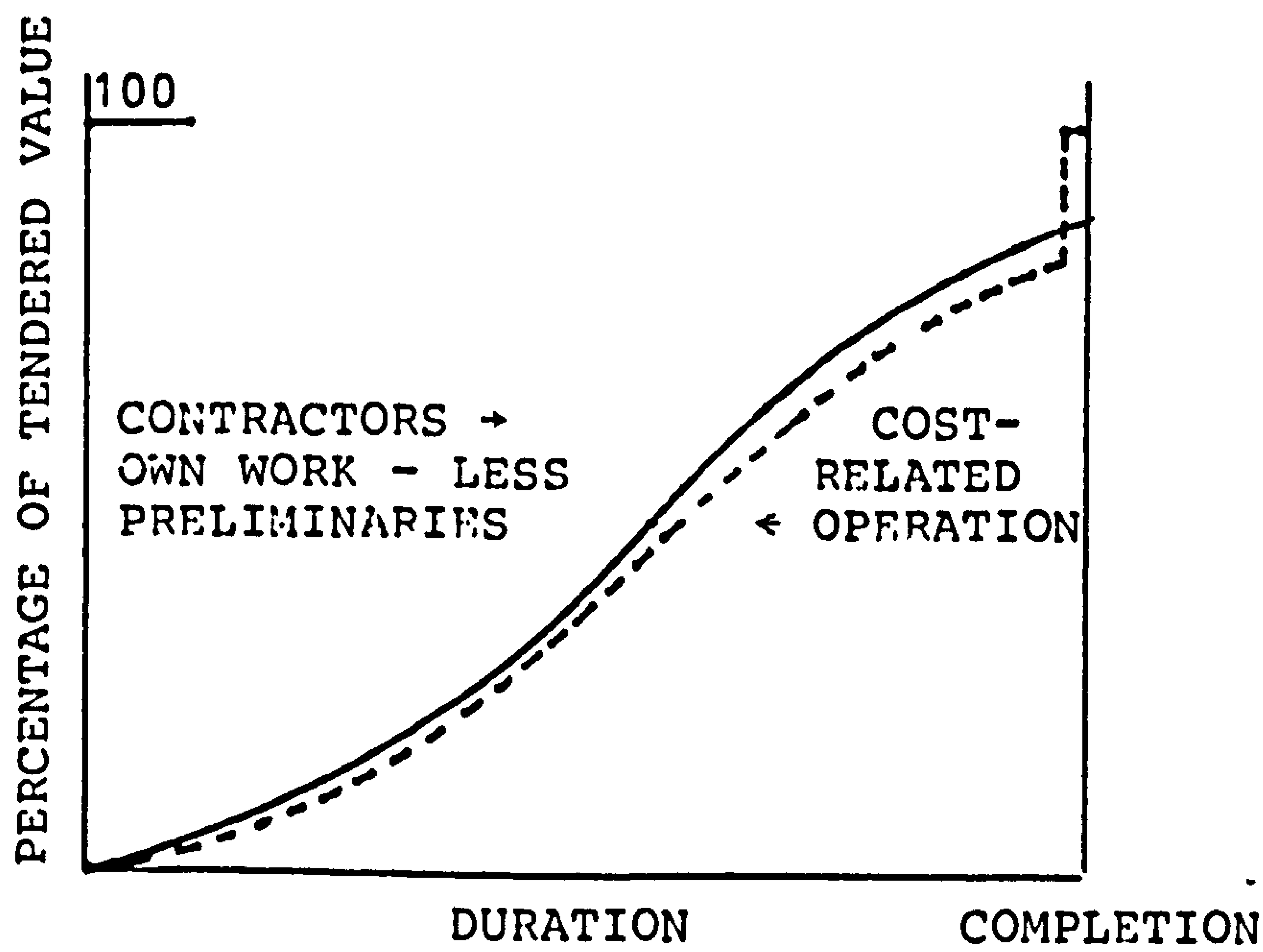

Figure 10.1: Contractor's own work less than tendered value.

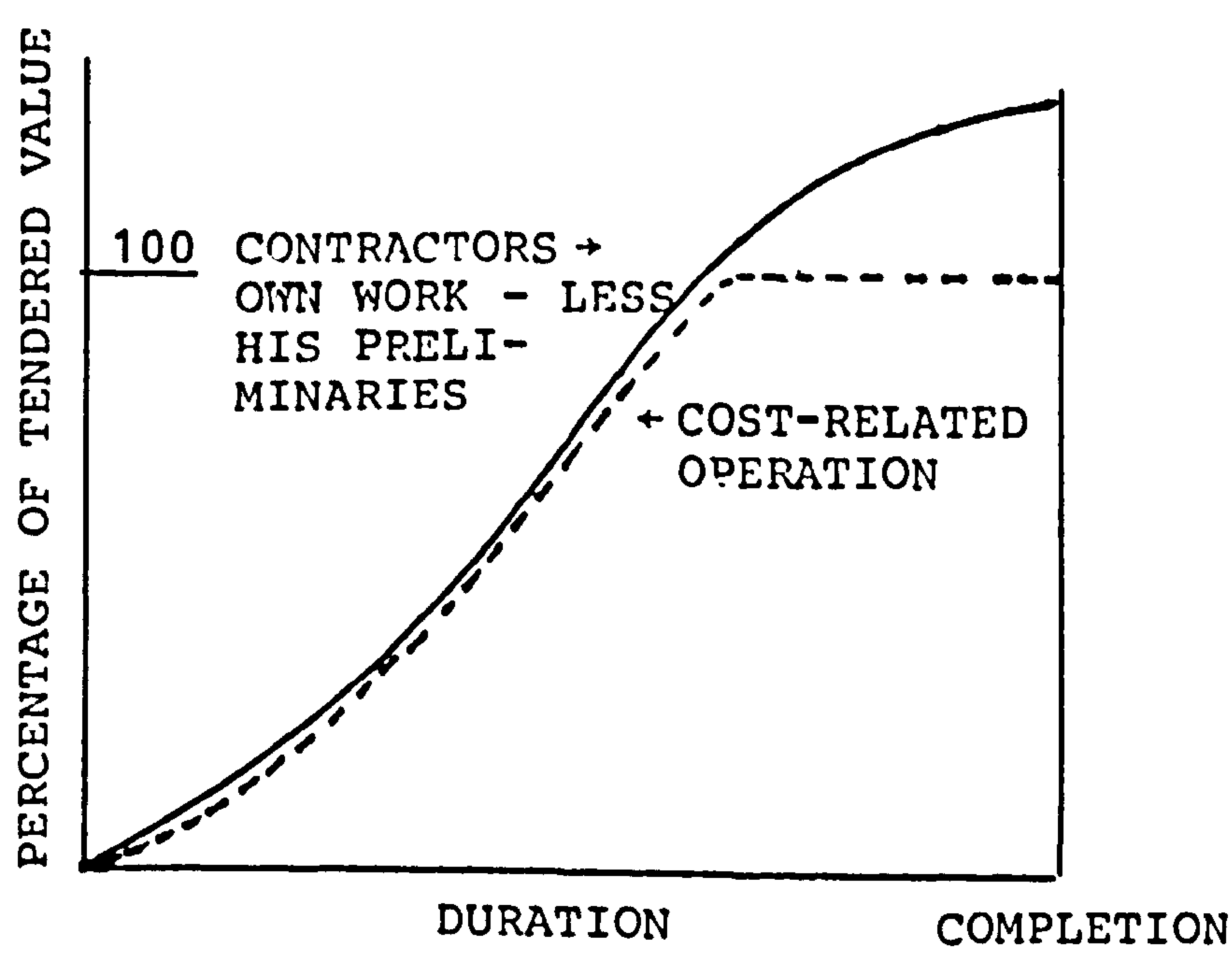

Figure 10.2: Contractor's own work more than tendered amount.

(C) SINGLE-PAYMENT ITEMS

The full value of the item is certified if the operation it covers has been completed. For instance, if the contractor sets up his concrete mixing plant and a sum for setting the mixing plant is in the Bill of Quantities then the whole Bill amount is to be certified. Where a proportion of the work covered by the single payment item has been done an agreed percentage of the Bill amount may be certified.

(D) COMPOSITE ITEMS

Where an item has both time-related and a single-payment components it may be broken into its components and the appropriate method used for each component.

10.2.1.1.2 GROUPING OF ITEMS OF PRELIMINARIES

Items of preliminaries are rarely valued individually. According to Ramus (146) several items of the same type may be grouped together and the appropriate method applied to the result. Turner (143) wrote that it is common practice to deal with the total value of preliminaries either as if the items are all cost-related or all time-related.

10.2.1.1.3 USE OF PRELIMINARIES BUDGETS

Barrett (157) writes that a Preliminaries Budget is usually constructed from the contract program and the tender build-ups of the preliminaries. A typical Preliminaries Budget is shown in Figure 10.3

Since the Preliminaries Budget contains the cumulative month-by-month total values of preliminaries it can be used as a basis for valuing all preliminaries. During valuation the actual position of the contract on the programmed progress scale is assessed and, the total preliminaries corresponding to that stage of progress is certified. The approach is very similar to stage payment which is discussed in Chapter 6.

10.2.1.1.4 PAYMENT AGAINST ACTUAL COSTS INCURRED

With this method the costs incurred by the Contractor in respect of preliminaries are certified. More detail on this method is provided in Section 6.1.1.

		TIME (MONTHS)																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
1	STAFF																								
	£000	20	20	20	30	50	50	50	50	50	50	50	50	50	50	50	50	50	50	30	20	20	20		880
2	PLANT																								837
		18	18·	25	25	47	47	47	47	47	47	47	47	47	47	47	47	47	47	25	25	25	18		
3	SCAFFOLDING																								
	£000	10	10	13	14	14	25	25	25	25	25	25	25	25	25	25	25	25	25	25	14	10	10		445
4	SITE ACCOM.																								
	£000	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		330
5	ELEC/GPO/WATE																								
	£000	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		110
6	SMALL TOOLS																								
	£000	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		110
7	TEMP. WORKS																								
	£000	30	30	30	30	30	30	30																	210
8	FUEL/CONSUM.																								
	£000	10	10	10	10	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	10	10	10		370
9	TRANSPORT																								
	£000	15	15	15					15			15									20	20	20		135
10	INSURANCE																								
	£000	5	8	10	10	10	12	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		295
11	WATCH/SECUR.																								
	£000	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		66
12	CLEANING																								
	£000																		5	5	2	2	2		16
13	FROST PRECAU																								
	£000	2	2	2																					6
	£000	138	141	153	147	199	212	215	200	185	185	200	185	185	185	185	185	185	190	148	134	130	123		3810
	£000		279	432	579	778	990	1205	1405	1590	1775	1975	2160	2345	2530	2715	2900	3085	3275	3423	3557	3687	3810		

10.2.1.2 PRELIMINARIES PARTIALLY OR WHOLLY INCLUDED IN MAIN WORK

Many textbooks (122, 123) on estimating indicate that preliminaries may be distributed throughout the rates in the Contract Bills either as a result of tender adjudication or as a deliberate pricing policy. For example, at the adjudication stage of a tender it may be decided to reduce the labour content in the tender. As the Bill rates will already have been written up it may be decided to adjust the preliminaries. The effect of such a procedure would be to redistribute an equivalent amount for preliminaries into the Bill rates. The same would apply in reverse if monies are added to the rates at adjudication stage.

Where monies for preliminaries are included in rates for main work the valuation of the appropriate main work will contain monies for the preliminaries so included. Details of the valuation of main work are given in Chapter 6. It follows therefore that where preliminaries are priced as part of main work their costs already incurred will not be recovered until the corresponding main work has been done and certified for payment. The Contractor will then be under-recovering his preliminaries and more of his capital is locked up. Including monies for main work in preliminaries means the Contractor will be paid for such monies before the work they cover is done; i.e. over-valuation takes place.

Variations may cause additional problems when preliminaries are priced in the Bill rates. As discussed in detail in Chapter 7, if quantities increase the Contractor will in effect over-recover preliminaires but if they decrease preliminaries will be under-recovered. Such situations tend to lead to claims which are dealt with in detail in Chapter 8.

10.2.2 THE VALUATION OF CIVIL ENGINEERING CONTRACT PRELIMINARIES

As discussed under Section 10.1.2 most items of civil engineering preliminaries are Method-Related Charges. The CESMM contains provisions on how MRC's are to be included in valuations.

Under paragraph 7.6 of the CESMM MRC's are not subject to admeasurement. Admeasurement refers to the measurement of quantities of work items which have actually been executed. By Clause 56, it is these quantities which should be paid for in the general case and not necessarily the quantities in the

BOQ which are supposed to be estimates. Method-Related Charges are therefore one of the exceptions.

Where the method adopted at construction corresponds with the method described in the BOQ, payment for MRC's usually follow the following principles (29):.

(i) TRC's are valued along the same lines as time-related preliminaries, as discussed under Section 10.2.1.1.1.

(ii) Fixed charges may be valued in the same manner as single-payment preliminaries.

The insertion of MRC's at tender does not bind the Contractor to adopt the method stated in the item description in carrying out the work. However, if a different method is adopted the determination of its payment may be less straight-forward. The CESMM lays down the following principles thereon:

(i) the Contractor and the Engineer agree on what times and upon which events various instalments of the Bill amount for the item will be paid for.

(ii) If the Contractor and the Engineer fail to agree as provided for in *(i)* then the Bill amount is added to the Adjustment Item and valued as described below.

(iii) The amount of an MRC can be changed only by a variation order.

10.2.2.1 THE ADJUSTMENT ITEM

Section G of the CESMM allows a tenderer to enter an item, called the Adjustment Item, in the Grand Summary Section of the Bill of Quantities either reducing or increasing his tender by a stated lump sum.

It sometimes happens that after writing up the Bills a tenderer wishes to adjust his tender. Reasons for wishing to do so include the following (29):

* arrival of revised quotations from suppliers or sub-contractors,
* lower quotations are received,
* final tender adjudication carried out by the tenderer's senior staff,
* errors in some parts of the Bill.

Adjustment of the tender by revising the rates and extensions of the affected parts may take a long time and where the need to carry out the adjustment arises right at the end of the tender period it can be a problem. The use of the preliminaries section to effect such adjustments and the problems caused thereby are discussed in Section 10.2.1.2.

The CESMM provides a more convenient way of making adjustments to the tender without altering rates and amounts within the work items themselves by allowing the entry of an Adjustment Item at the end of the BOQ.

Under paragraph 6.4 of the CESMM the Adjustment Item is certified in interim payments 'pro rata' to the value of the work items (the amount referred to in sub-clause 60 (2)(a)) in interim payment until the calculations produce an amount greater than the original Adjustment Item sum in the Bill. Where the value of work items is different from the total of their tender amounts the principles used in valuing cost-related preliminaries described in Section 10.2.1.1.1 are applicable.

10.3 THE PRACTICE OF SUB-CONTRACTING

The basis of employing sub-contractors is that the Main Contractor obtains vicarious performance of some of his duties while remaining primarily responsible to the Employer for the works (133).

Cooke (134) writes that one of the first tasks of the Main Contractor on being informed of the success of his tender is to place his sub-contracts. There are two main types of sub-contractors (88):

* domestic sub-contractors who are chosen by the Main Contractor,
* nominated sub-contractors who are chosen by the Employer or his professional advisers.

10.3.1 DOMESTIC SUB-CONTRACTING

There are a number of reasons why so many Main Contractors sub-contract portions of their work. They include:

(i) In some trades, particularly the plumbing, electrical, and painting trades the sub-contractors maintain an organization of skilled specialists, making it possible to do certain parts of the work better and more economically than might be done by someone less well organized (153).

(ii) Many specialists require equipment peculiar to their trade and it is often more economical to sub-contract the work than to buy or rent the equipment (153).

(iii) According to Broughton (118) some contractors employ sub-contractors in order to pre-determine the cost of the work, especially the labour element.

(iv) Since contracting is a risky business and

can require large amounts of capital, sub-contracting is often used as a device to spread both the risk and the financial burdens of a large job (153).

10.3.1.1 DISADVANTAGES OF SUB-CONTRACTING

The disadvantages of sub-contracting include:

(i) Loss of Control: As soon as a Main Contractor sub-contracts a portion of his work, he sacrifies a certain amount of control over that part of the project (153).

(ii) Co-ordination Problems: The work of the Main Contractor and of his sub-contractors need to be co-ordinated so as to complete the project within the Contract Period. Faulty co-ordination can create accounting, financial, and credit problems for the Main Contractor (153).

(iii) Default: If a sub-contractor defaults the consequences can be grave for the Main Contractor. Re-organising to do the work himself or selecting a new sub-contractor will invariably cause delay and extra direct costs leading possibly to liability for liquidated damages.

Where the cause of default is insolvency, bankruptcy or liquidation the Main Contractor may not be able to recover his losses caused by the default. Such a sub-contractor can leave the Main Contractor with liability for unpaid bills relating to work for which the sub-contractor has already been paid (133).

(iv) Contractual Conflicts: A fundamental rule is that a contract is in the nature of a bond or a rope between the parties who have created the contract by their agreement (133). This rule is referred to as the Doctrine of Privity of Contract. There is a contract between the Employer and the Main Contractor and a separate contract between the Main Contractor and his sub-contractor. It follows therefore that the rights and duties of a sub-contractor are not governed by the terms of the main contract unless they are specifically incorporated into the sub-contract. A powerful sub-contractor may refuse to enter into a sub-contract undertaking towards the Main Contractor such obligations and liabilities as will enable the Main Contractor to discharge his own obligations and liabilities towards the Employer. In such a case, the Main Contractor will not be able to obtain indemnity from the sub-contractor for causing him to incur damages under the main contract.

(v) Interference: The JCT and ICE and other standard terms require consent from the Architect/Engineer to sub-contracting. Such permission may not always be given without independent investigations to establish the technical, financial and organisational capabilities of the sub-contractors (133). Where there is disagreement delays and extra costs can arise.

10.3.2 NOMINATED SUB-CONTRACTING

Quite apart from sub-contractors appointed by the Main Contractor, the JCT and ICE contracts allow the Employer or his professional advisers to order the Main Contractor to enter into a sub-contract with a specified sub-contractor. Such a sub-contractor is called a nominated sub-contractor.

The reasons for nominated sub-contracting include the following:

(i) It has already been said above that sub-contracting can sometimes lead to the reduction of the costs of executing the work sub-contracted. The Employer may wish to take the benefit of the reduction himself.

(ii) The Employer may for reasons of quality, expedition and a variety of other reasons prefer a particular sub-contractor to carry out a particular part of the project. This is particularly so for sub-contractors with proprietary systems (133).

(iii) If the time between contract award and construction is limited the Contractor may not be able to obtain competitive tenders for work which is most likely to be sub-contracted. He will make up for this by raising his tender. If the Employer selects the sub-contractor within the longer time scale available to him it might lead to a reduction of the cost to him of the project (133).

(iv) Some specialist work, mechanical or electrical installation or structural steelwork, for example, may have long delivery times. To avoid the consequent delays later the Employer may wish to place orders before he has even awarded the Main Contract (133).

10.3.2.1 PROCEDURE FOR NOMINATION

There are two main types of procedures for nominating sub-contractors:

* Pre-contract Nomination: The Promoter or his professional advisers include in the tender documents information on prospective nominated sub-contractors for major items. A contractor whose tender is successful is expected to enter into sub-contracts with the specified sub-contractor unless he is legally entitled to object and he successfully does so.

* Post-contract Nomination: There are four situations:

  (i) The Main Contractor is ordered to enter into a sub-contract in respect of a Prime Cost (PC) item provided in the Bill of Quantities (Clause 58 (4) of the ICE conditions and Clause 35.1.1 of the JCT).

  (ii) The Main Contractor is ordered to enter into the sub-contract for which a provisional sum will be used (Clause 58.1.7 of the ICE Contract and Clause 35.1.2 of the JCT Contract).

(iii) Through the issue of a valid variation order (Clause 51 of the ICE Contract and Clause 35.1.3 of the JCT forms).

(iv) Agreement between the Contractor and the Employer/his professional advisers.

10.4 THE VALUATION OF SUB-CONTRACTED WORK

The method of measuring sub-contracted work for the purpose of including it in interim valuation would depend on how the work is covered in the Bill of Quantities. Since the work of domestic sub-contractors is work meant to be done by the Main Contractor, the method of measurement is that applicable to the work of the Main Contractor.

However the recommendations of SMM6 for the coverage of nominated sub-contractor's work in the Bill of Quantities is different from those of the CESMM.

10.4.1 THE JCT RECOMMENDATIONS

Work to be done by a nominated sub-contractor is to be covered by the following items:

(i) Prime Cost sum: represents the estimated price of the work to the sub-contractor.

(ii) General Attendance Item: covers the charges by the Main Contractor for the sub-contractor's use of the following facilities to be provided by the Main Contractor:

* temporary roads,
* paving and paths,
* standing scaffolding,
* standing power-operated hoisting plant,
* the provision of temporary lighting and water supplies,
* clearing away rubbish,
* the provision of office accommodation and storage for his plant and materials,
* use of messrooms,
* sanitary accommodation.

(iii) Other Attendance Items: An item to be provided in each case for:

* special scaffolding or scaffolding additional to the Contractor's standing scaffolding,
* the provision of temporary access roads and hardstanding in connection with structural steelwork, pre-cast concrete components, piling, and other heavy items of plant,
* unloading, distributing, hoisting and placing in position, giving in the case of significant items the weight and/or size.

* the provision of covered storage accommodation including lighting and power thereto,
* power supplies,
* maintenance of specific temperature or humidity levels,
* any other attendance which has not been included in the General Attendance.

(iv) An Item for Profit: It can be a lump sum or a percentage of the PC item.

10.4.2 THE ICE CONDITIONS

The CESMM recommends that the work of a nominated sub-contractor should be covered by the following three items:

(i) Prime Cost Item: a lump sum to represent the charge of the sub-contractor.

(ii) General Labours Item: covers, in the absence of contrary and express conditions, the charges of the Main Contractor for the use by the sub-contractor of any of the following facilities provided by him:

* scaffolding,
* messrooms,
* sanitary accommodation and welfare facilities,
* office accommodation and storage of plant and materials of the sub-contractor,
* lighting and water.

(iii) Other Charges and Profit Item: a percentage on the Prime Cost item for other charges and profit.

10.4.3 ADMINISTRATIVE PROCEDURES FOR VALUING SUB-CONTRACT WORK

Usually the Main Contractor is responsible to the Employer for the work of sub-contractors, both domestic and nominated, and it is he who is required to make payment applications on their behalf to the Architect/Engineer.

The normal practice is to come to an agreement with the sub-contractors as to the times when they should submit payment applications on the sub-contracts for incorporation in the application of the Main Contractor (146).

Prior to the issue of each interim payment certificate, the Contractor is required to comply with any request of the Architect/Engineer to provide reasonable proof that he has made relevant payments due to nominated sub-contractors under previous certificates (Clause 35.13.3 of the JCT Form and Clause 59C of the ICE Contract). If reasonable proof is not provided, the Employer is empowered to pay nominated sub-contractors directly and to deduct the amount of such payment from monies due the Contractor under the next certificate.

10.4.4 VALUATION PROCEDURE

The value to a nominated sub-contractor of the work he has done is determined from his payment application or from an independent assessment by the Main Contractor or the Quantity Surveyor. Even where a domestic sub-contractor makes a payment application it will usually be adjusted to take into account the sub-letting margins of the Main Contractor.

Items for profit are valued 'pro rata' to the appropriate Prime Cost Sum/Item in the Bill of Quantities. Where items for profit are stated as percentages of Prime Cost Sum/Items, the same percentages are applied to the values included in the valuation for the appropriate Prime Cost Sum/Item to obtain the amounts for profit. Where profit additions are shown as lump sums without any indication of the method of calculation, such sums are to be adjusted 'pro rata' to the values of the appropriate PC items.

Attendance items are valued 'pro rata' to the proportion of the PC Sum/Item earned up to the full lump sum. Where the actual cost of a PC item is different from its bill amount the attendance item is not affected unless it is affected by a variation order. Ramus (146) advises that where a Contractor prices attendances as a percentage of the corresponding PC item, the item of attendance should be converted to fixed lump sums with the Contractor's agreement before signing the contract. This is intended to avoid disputes when the amount for the PC item turns up to be different from its Bill amount.

Where a PC item is deleted for any reason the Contractor is still entitled to amounts for attendance and profit (133, 146). None of the textbooks consulted specifies the method for determining the instalments to be included in interim payments. Valuation in proportion to the total contract completed would be reasonable.

10.4.5 DISCOUNTS

Discounts are amounts by which quoted or stated costs or prices may be reduced when paying accounts, usually depending on the fulfilment of specified conditions (146).

There are two main types of discounts encountered in construction work (133):

* Trade Discounts: These are discounts customarily allowed off the prices on standard price lists of materials and goods in certain trades.

* Cash Discounts: These are allowed off invoice prices for prompt payment.

Under both the JCT and ICE Conditions the Contractor is under a duty to give the Employer credit for trade discounts received or receivable from nominated sub-contractors and suppliers. However, whereas with the ICE contract the Contractor is entitled to keep all cash discounts, with the JCT Form the Contractor is only entitled to the cash discount only if it is not more than 2½% in the case of nominated sub-contractors and 5% in the case of nominated suppliers.

10.5 CONTROL OF SUB-CONTRACTED WORK

The type and scope of corrective action on sub-contracted work is different from that on the contractor's own work. Trimble and Clark (183) write that in the latter case the manager can take steps to improve productivity or reduce waste whilst for sub-contracted the only options available include:

* taking steps to reduce delays caused by the Main Contractor himself or by the other sub-contractors;
* keeping evidence to support claims against recalcitrant sub-contractors;
* keeping evidence to claim against the client where the client is responsible for extra costs;
* careful sub-contracting.

There are two main types of control procedures by which these options may be exercised: qualitative and quantitative procedures.

10.5.1 QUALITATIVE CONTROL PROCEDURES

There are several ways of exercising qualitative control over sub-contractors. They include:

* careful selection of sub-contractors,
* the use of effective conditions of contract,
* efficient co-ordination of the work of all contractors engaged on the works.

10.5.1.1 SELECTION OF SUB-CONTRACTORS

The JCT, ICE and some other standard forms of contract require the consent of the Architect/Engineer to sub-letting of any part of the work. A prudent Architect/Engineer would want evidence of the possession of adequate finances, resources, expertise and dependability by potential sub-contractors. As any refusal will often mean delay, the Main Contractor should prevent this by carrying out a thorough investigation of those factors before deciding on any sub-contractor. Such a practice would also reduce the likelihood of default by sub-contractors. Coombs and Palmer (153) write that wherever the risk of default is serious the main contractor should demand performance bonds from the sub-contractors concerned. In the case of nominated sub-contractors the main contractor usually has a right to raise reasonable objections.

10.5.1.2 CONTRACT CONDITIONS

The Main Contractor should ensure that a proper sub-contract is entered into whereby the sub-contractors undertake towards the Main Contractor such obligations and liabilities as will enable him to discharge his own obligations and liabilities to the Employer, indemnifying him against any failure to perform such obligations. A valid forfeiture clause should be included for use as a final resort (133). There are standard forms (138, 139) for sub-contracts and Abrahamson (133) recommends their use without amendments. Should any amendments or the drafting of special conditions be necessary legal counsel should be sought as such amended conditions will usually be constrained against the Main Contractor. This is referred to as the 'Contra Proferentem' rule (133). Provisions for appropriate security such as appropriate retention should also be made.

10.5.1.3 CO-ORDINATION OF SUB-CONTRACTED WORK

The Contractor should co-ordinate the work of each sub-contractor for the following reasons (153):

* to prevent delays to his own progress,
* preventing extra costs to himself,
* preventing claims from other sub-contractors.

The Main Contractor should have this in view right from the decision to sub-contract, through sub-contractor selection to actual construction on site. If, inspite of all precautions claim situations still arise, they should be monitored and dealt with quickly.

10.5.1.4 FAIR PAYMENT

The Main Contractor should avoid both underpayment and overpayment of his sub-contractors. Overpayment may erode financial securities provided by sub-contractors and also adversely affect his cashflow. Under-payment of sub-contractors, though tending to improve the Main Contractor's cashflow, may be shortsighted. A policy of underpayment could bring about defaults that otherwise might be avoided (153). Cooke and Jepson (155) write that the practice of underpayment could mislead the contractor as to his own financial performance.

The details of an interim payment on the values of nominated sub-contractors' work are usually drawn up in a Statement of Retention and of Nominated Sub-contractor's Values, a sample of which is shown in Appendix 5. There is no reason why the Contractor cannot expand such a statement to include his domestic sub-contractors.

10.5.2 QUANTITATIVE CONTROL OF SUB-CONTRACTORS

Gobourne (160) writes of two control procedures which may be applied to sub-contracted work;

* the determination of letting margins,
* the control of attendances.

10.5.2.1 LETTING MARGINS

Figure 10.4 shows a typical letting margins report. The use of such a report as a basis of corrective action appears to be limited. In the case of domestic sub-contractors it may be used to assess quotations but once the sub-contract has been placed there is obviously very little the Main Contractor can do about the margin. In the case of nominated sub-contractors the margins report is unnecessary.

An incidental use of the report is that by isolating the contribution of sub-contracted work the performance of labour and plant may be more apparent.

10.5.2.2 ATTENDANCE

The Main Contractor has to 'attend upon' sub-contractors. Gobourne (160) writes that attendance may be recoverable from the Employer either as daywork or as a measurable item. Where attendance is a measurable item SMM6 and the CESMM provide for attendances in slightly different ways. They are described in Section 10.4.

According to Ramus (146) in practice items for attendances are usually of the following types:

* a lump sum,
* a percentage of the price of the P.C. item.

Attendances may be regrouped into, or used individually as Work Packages and costs collected on them. The cost of each Work Package may then be compared with revenues received or receivable to determine variances. If the variance is adverse it may mean that the Main Contractor is providing more attendance than he is obliged to and he may consider

XYZ CONSTRUCTION LTD			CONTRACT	
SUB-CONTRACTORS' LETTING MARGINS				
SUB-CONTRACT	TENDER VALUE £	SUB-CONTRACT COST £	GAIN £	LOSS £
Labour	41,000.00	37,500.00	3,500.00	-
Painting	38,778.00	35,000.00	3,778.00	-
Structural Steelwork	77,950.00	72,217.00	5,733.00	-
Plumbing	55,090.00	56,479.00	-	1,389
:	:	:	:	:
:	:	:	:	:
:	:	:	:	:
:	:	:	:	:
Electrical Services	111,547.00	98,665.00	12,882.00	-
			35,750	10,910.00
			10,910	
	Overall Letting Margin:		24,840	

Figure 10.4: An Example of a Letting Margins Report

charging the sub-contractors accordingly. It may also mean his estimate was unrealistic in which case his estimating data may be updated for the benefit of future jobs.

Revenue cannot be obtained without requesting valuations from the sub-contractors concerned. As such requests on only a monthly basis will usually be acceptable it means that such attendances can be subjected to only monthly controls.

10.6 PROVISIONAL SUMS

A civil engineering Bill of Quantities prepared in accordance with the CESMM may contain the following types of provisional sums:

(i) a provisional sum for the prime costs of each of the following expected to be used in dayworks:
- labour,
- plant,
- material (paragraph 5.7 of CESMM).

(ii) Provisional sums for specific contingencies (paragraph 5.17 of CESMM) in the General Items section of the Bill of Quantities.

(iii) A provisional sum for a general contingency allowance in the Grand Summary of

the Bill of Quantities (paragraph 5.17).

Under both the JCT and ICE Forms the Architect/Engineer has the power to authorize work covered by a provisional sum to be done either by the Contractor or a nominated sub-contractor (Clause 13.3 of the JCT form and 58(7) of the ICE form).

Where the work covered by a provisional sum is done by the Main Contractor it is to be valued as an ordinary variation as described in Chapter 7. Where the work has been done by a nominated sub-contractor it is to be valued in the same way as other nominated sub-contractors' work (Clause 13.4.1 of the JCT Form and 58(7) of the ICE Form). In the case of the ICE Form the percentage for profit is the value stated in the Appendix to the Form of Tender. Under the JCT Form the percentage to be applied is any such percentage stated in the order for the use of the provisional sum, or if no such rate is stated a reasonable rate is to be agreed to (Clause 30.2.1.5).

Amounts for attendance on nominated sub-contractors' work ordered under a provisional sum is to be decided by the Engineer in the case of the ICE Form. Where the amounts for attendances are not agreed between the Architect and the Contractor it does seem that the Contractor may submit a claim for direct loss/expense under Clause 26.

CHAPTER ELEVEN

PRICE ADJUSTMENTS DURING VALUATIONS

In construction contracts with considerable contract periods, provisions are often made for the reimbursement of extra costs incurred by the Contractor due to inflation. Such contracts are sometimes referred to as fluctuating price contracts.

This chapter describes the procedures and calculations involved in determining the amounts of reimbursements for inflation for both building and civil engineering contracts.

There are two basic approaches to determining reimbursements due to inflation (146):

* the Traditional Approach,
* the Formulae Approach.

11.1 THE TRADITIONAL APPROACH

The approach of the traditional method is that the Contractor submits a tender based on current costs and during the execution of the work he is reimbursed 'actual' costs incurred due to inflation. Though the basic approach is the same for building and civil engineering works, the contractual procedures are different.

11.1.1 BUILDING CONTRACTS

The object is to ascertain the actual amount of fluctuations in costs and prices under appropriate clauses of the JCT Conditions of Contract. Depending on which fluctuation options are selected in the Appendix to the Conditions the increases in costs under the following heads are recoverable:

(i) statutory contributions, levies, and taxes relating to labour;

(ii) labour costs;

(iii) materials costs;

(iv) duties and taxes on materials.

11.1.1.1 PRE-CONTRACT PREPARATIONS

The following procedures are necessary at the pre-contract stage:

(i) The Employer's professional advisers should make a choice of the options under Clause 37 to give legal effect to the method of recovery of fluctuations. The clause states that one of Clauses 38, 39 or 40 is to apply to the Contract. To determine fluctuations by the traditional method either Clause 38 or 39 should be selected. Whichever clause is

selected is to be mentioned in the Appendix to the Conditions of Contract.

(ii) Where fluctuations are to be recovered under Clause 39 the Contractor should include in his tender:

* a basic list of materials, goods, electricity and fuel prices as required by Clause 39.3.1
* a list of basic transport charges as required by Clause 39.1.1.

(iii) The Contractor is required to insert in the Appendix to the Conditions a percentage addition on fluctuation payments he may wish to recover.

11.1.1.2 PRICE ADJUSTMENT PROCEDURES

According to Clauses 38 and 39, fluctuations may be recovered under the following headings:

* statutory contributions, levies and taxes,
* wages of labour,
* materials prices,
* fares of workpeople,
* payments to domestic sub-contractors,
* refunds of premiums,
* duties and taxes on materials.

The amount to be paid is determined by taking the cumulative totals of the changes, or differences as the case may be, in the costs of goods and services under the headings above. Payment applications must be preceded by written notices as required under Clauses 39.5.1 and 38.4.1. As agreement between the Quantity Surveyor and the Contractor may be required all payments must be supported by documentary evidence such as:

* invoices from suppliers;
* invoices/receipts from bodies to which contributions, levies, and taxes are payable;
* evidence that the amounts of materials and labour in respect of fluctuations payments are demanded are not more than needed on the contract;
* calculations supporting amount payable.

Fluctuations payable are to be included in interim and final payments but are not subject to retention. A sample materials fluctuations payment request is shown in Appendix 7.

11.1.1.3 RECOVERY OF FLUCTUATIONS BEYOND THE DATE OF COMPLETION

By Clauses 38.4.7 and 39.5.7, if the Date of Completion (as stated in the Contract or as extended) is overrun the amounts of fluctuation recoverable are 'frozen' at the levels which were operative at the Date of Completion.

11.1.2 CIVIL ENGINEERING CONTRACTS

The ICE Conditions make provisions for the recovery of, or allowance for 'actual' increased or decreased costs incurred by the Contractor in relation to only labour and VAT on taxable supplies (Clause 69). Any other provisions would have to be incorporated as special conditions under Clause 72.

Fluctuations additions are to be included in interim and final certificates. However, unlike in building contracts, such amounts are subject to retention.

11.2 THE FORMULA APPROACH

The formula approach involves recovery by references to formulae against changes in indices which reflect national wage and price movement. For items subject to the formula recovery, individual costs included in the building up of a tender are not used in the calculation of reimbursements. There is no need therefore, from the point of view of operating the formula as such, to specify the materials subject to fluctuation provisions and no need to submit a list of basic materials' prices. Formula reimbursement results from changes in the indices from the base index as defined in the contract documents, irrespective of the actual extra cost or savings incurred by the Contractor.

It can be seen from the description of the two approaches that reimbursement of fluctuations calculated on the basis of the traditional approach does not include overheads and profit unless otherwise provided for in the Contract. The formula methods allow reimbursement of fluctuations on overheads and profit (146).

11.2.1 BUILDING CONTRACTS

The formula method involves recovery against changes in indices compiled, maintained and published by the Property Services Agency of the Department of the Environment. These indices are usually called the National Economic Development Office (NEDO) Series 2 indices but sometimes they may be referred to as the 'Osborne' indices.

There is an index number for each of 48 Work Categories which are classifications of general building works. The Work Categories are listed in Appendix 3. Work Category indices are composite indices covering resources of labour, materials and plant. Changes in a Work Category index number result from changes in the price levels of the resources contained within that Category. Work Category indices are derived from resource indices, each specified to represent changes in price levels of particular resources, by combining with resource weightings indicating the relative value of each resource within the Category at a given date.

Reimbursements for inflation are determined from changes in the indices from the corresponding base indices defined in the contract documents. Base indices are the indices current during the Base Month stated in the Appendix to the Conditions. According to Ramus (146) the Base Month is normally the one prior to that in which the tender is due for return.

11.2.1.1 PRE-CONTRACT PROCEDURES

The following are necessary for the use of the building formula method:

* incorporation of the method into the Contract,
* completion of a Schedule of Fluctuations,
* Formation of Work Groups,
* Definition of Structural Steel.

11.2.1.2 INCORPORATION OF THE METHOD

The formula method is incorporated in the 'With Quantities' and 'With Approximate Quantities' variants of the JCT Form, in both Local Authorities and Private Editions, by means of Clause 40, as the alternative to Clauses 38 and 39. It may also be applied to contracts which are based on the 'Without Quantities' variants of the Form by suitably amending the Conditions of Contract. Ramus (146) suggests that it may also be used for schedules of rates contracts.

Clause 40.1 of the JCT refers to a separate document called the 'Formula Rules' (190) which sets out the formulae and defines their use. Clause 40 also incorporates the 'Formula Rules' into the Standard Form.

11.2.1.3 COMPLETION OF SCHEDULE OF FLUCTUATIONS

This is required by Rule 19 of the 'Formula Rules'. In order to apply the formula all measured work should be allocated to whichever of the following the various Bill items belong:

* one of the Work Categories,
* fix-only work,
* Contractor's specialist work,
* provisional sums subject to formula adjustment,
* balance of adjustable work,
* work excluded from formula adjustment.

The scope of the unfamiliar of these groupings are described below.

(A) WORKS CATEGORIES

They are described under Section 11.2.1.

(B) 'FIX ONLY WORK'

In certain circumstances when there is a significant value of work in respect of items of 'fix only' it may be appropriate to create a weighted index covering all such work (193). The weighted index is called a 'fix only' index and its calculation is described in the Series 2 NEDO Guide (193).

'Fix only' work items may also be dealt with by allocating them to appropriate Work Categories, or including them in the 'balance of adjustable work' which is described below. The Series 2 NEDO Guide (193) requires that where the method of dealing with 'fix only' items have not been specified in the Contract the method to be adopted should be agreed with the Contractor.

(C) SPECIALIST WORK

Specialist work is work for which one of the specialist engineering formulae in Part III of the 'Formula Rules' applies. There are no Work Categories for specialist work.

(D) BALANCE OF ADJUSTABLE WORK

This is the balance of the Main Contractor's work which ranks for adjustment but which is not allocated to Work Categories or specialist work.

Examples include preliminaries, water for the works, insurances, and attendances on nominated sub-contractors.

Rule 11 provides 2 alternative ways of producing the Schedule:

* the Quantity Surveyor prepares it and includes it in the tender documents,
* the Contract Bills at tender are appropriately annotated and the Schedule is later prepared from the annotation.

No matter which alternative is used the resulting categorization is binding on both parties.

No particular form has been specified for the Schedule but Standard Forms are commonly used. An example of a Schedule is shown in Appendix 9. The form is used once only to identify the Work Category to which each Bill item is allocated. Unless the BOQ has been annotated to indicate the appropriate Work Categories the second column is completed by the Quantity Surveyor and issued to tenderers, preferably with the tender documents or as soon as possible thereafter. Completion of the third column may be delayed until the acceptance of the tender.

11.2.1.4 FORMATION OF WORK GROUPS

Work Categories may be combined into a number of Work Groups for which weighted index numbers to be calculated would apply. For example, if the Bills of Quantities are prepared in elemental/operational form, index numbers representative of each element/operation, or groups of elements/operations, may be calculated. If trade bills are used, suitable trade groupings may be established.

The 'Formula Rules' require that where this procedure is to be adopted the following should be complied with:

(i) The Appendix to the Conditions should be filled to indicate that Part II of the 'Formula Rules' shall govern the Formula adjustment;

(ii) the BOQ should define what Work Categories are to be included in each Work Group;

(iii) the Base Month should be stated in the BOQ;

(iv) the Schedule of Fluctuations prepared should show the total value of each Work Category within each Work Group.

11.2.1.5 STRUCTURAL STEEL PROVISIONS

Where structural steelwork is specified in the contract BOQ to be undertaken by the Main Contractor the Bills should state which of the following alternatives shall apply for the adjustment of the price of the structural steelwork:

(i) allocating all structural steelwork to Category 27 and determining the adjustment either by the Work Category method or Work Group method;

(ii) use the specialist formula under Rule 63.

11.2.1.6 PRICE ADJUSTMENT AT VALUATIONS

The Series 2 NEDO Guide (193) requires the assessed value of work executed and included in a valuation to be allocated to:

* Work Categories or Work Groups
* balance of adjustable work
* specialist work
* 'fix only' work

The appropriate formula is then applied to each part as described below

11.2.1.6.1 WORK CATEGORIES

The appropriate formula, contained in Rule 9 of the 'Formula Rules', is expressed in algebraic terms as follows, and is applied to each work Category in each valuation:

$$C = \frac{V(Iv - Io)}{Io} \qquad (190)$$

Where,

C = the amount of the price adjustment for the Work Category to be paid to, or recovered from the Contractor.

V = the value of work executed in the Category during the valuation period.

Iv = the index number for the Work Category for the month during which the mid-point of the valuation period occurred.

Io = the Work Category index number for the Base Month.

An alternative form of this formula may be expressed as follows:

$$Cg = V \times \frac{Iv}{Io} \qquad (190)$$

Where,

Cg = the gross amount due on each valuation, i.e. the sum of the value of work executed in the Valuation Period and the amount of fluctuations adjustment.

The other symbols have the same meaning as in the first expression.

11.2.1.6.2 WORKS GROUPS

The appropriate formula is that of Rule 29. It is expressed in algebraic terms as follows, and is applied to each Work Group in each Valuation Period:

$$C = \frac{V(Iv - Io)}{Io} \qquad (190)$$

Where,

C = the amount of the price adjustment for the Work Group to be paid to, or recovered from, the Contractor.

V = the value of work executed in the Work Group during the Valuation Period.

Iv = the weighted index number for the Work Group for the month during which the mid-point of the Valuation Period occurred.

Io = the weighted work group index. number for the Base Month.

11.2.1.6.3 BALANCE OF ADJUSTABLE WORK

The formula is stated by the 'Formula Rules' as:

$$C = Vo \frac{Cc}{Vc} \qquad (190)$$

Where,

C = the amount of adjustment for the Balance of Adjustable Work to be recovered from, or paid to the Contractor,

Vo = the value of work in the Balance of Adjustable Work for all categories for the Valuation Period,

Cc = the total amount of the adjustment of all Work Categories for the Valuation Period to be paid to, or recovered from, the Contractor,

Vc = the total value of work in all Work Categories for the Valuation Period.

This formula is subject to the proviso that where the value of work in any Valuation Period contains no work allocated to Work Categories any Balance of Adjustable Work included in the value of work shall, unless otherwise agreed, be allocated to Work Category 2/1 and adjusted by the appropriate formula.

11.2.1.6.4 SPECIALIST WORK

The appropriate formula to apply is contained in Part III of the 'Formula Rules'. This research was limited to general building work with the intention that extensions to include specialist work would be made later on.

11.2.1.6.5 'FIX ONLY' WORK

According to the 'Formula Rules' where the valuation includes 'fix only' work a weighted index should be calculated along the same lines as that for the index for the Base Month. The appropriate formula to use is the same as for the Work Categories.

11.2.1.7 CONSIDERATION IN DETERMINING BUILDING PRICE ADJUSTMENTS

In the assessment of adjustments attention is usually paid to the considerations discussed below.

11.2.1.7.1 PROVISIONAL INDICES

Indices for any month when first published are provisional. This is because the collection of the information to compile the indices takes considerable time and effort if the indices are to be accurate. Usually firm indices are published when sufficient information is available and the calculations have been performed.

11.2.1.7.2 VALUATION PERIOD

The value of work carried out during the Valuation Period is needed to apply in the formulae. The Valuation Period is defined as commencing on the day after that on which the last valuation was done and finishing on the date of the succeeding valuation.

The index number for the Valuation Period are those for the month in which the mid-point of the Valuation Period occurs. If the Valuation Period has an odd number of days, then it will be the middle day of the Period; if it contains an even number, the mid-point will be the middle day of the Period remaining after deducting the last day.

11.2.1.7.3 RETENTION

Fluctuation reimbursements calculated by the formula method, unlike those ascertained by the traditional method, are subject to retention deductions.

11.2.1.7.4 WORK EXECUTED AFTER THE DATE OF COMPLETION

Under the provisions of Clause 40.7 of the JCT Form, the formula is applied to the value of work executed after the completion date (or extended date of completion) but using the indices applicable to the month in which that date falls. This has the same effects as if all the work outstanding after the completion date had been carried out during the month in which the completion date occurred.

11.2.1.7.5 VALUATIONS AFTER PRACTICAL COMPLETION

The method for adjusting the value of work which is included in interim payments made after the Certificate of Practical Completion has been issued is given by Rule 28 of the 'Formula Rules' as;

$$C = \frac{V \times Ct}{Vt} \qquad (190)$$

Where,

C = the amount of the adjustment to be paid to, or recovered from, the Contractor;

V = the value of work executed.

Ct = the net total of the formula adjustment in previous certificates excluding fluctuations on specialist engineering work.

Vt = the total value of work but excluding Contractor's specialist work included in previous certificates.

This formula has the effect of applying the average fluctuations over the contract period to the additional work involved.

11.2.1.7.6 DEALING WITH ERRORS

Rule 5a of the 'Formula Rules' allows the Quantity Surveyor to correct the following types of error:

(i) arithmetical errors in the calculation of the adjustment;

(ii) incorrect allocation of the values of Work Categories to Work Groups;

(iii) incorrect allocation of work as Contractor's specialist work;

(iv) use of incorrect index numbers.

Errors in preparing valuations are discussed in Chapter 5.

The NEDO Guide (193) on the use of the Series 2 indices contains examples of all the calculations involved.

11.2.2 CIVIL ENGINEERING PRICE ADJUSTMENT BY THE FORMULA METHOD

The formula method for the adjustment of prices of civil engineering work for inflation involves recovery against changes in indices compiled and maintained by the Property Services Agency (PSA) of the Department of the Environment (DOE), the Department of Trade and Industry and the Department of Energy. These indices (shown in Appendix 10) which are called the NEDO indices for civil engineering or the 'Baxter' indices are published in a monthly bulletin (215).

In simple terms the formula may be

described as follows. The concept depends upon these indices representing the cost of resources. At the beginning of a contract base indices, which represent the index values at the time of the tender and hence the cost of resources at that time, are established. At each monthly valuation reimbursement for inflation is then determined from the weighted differences between the current indices and their corresponding base indices.

The formula described above is often referred to as the main civil engineering formula to distinguish it from a second formula which is sometimes used when a contract contains a considerable structural steelwork element. This second formula is often called the Fabricated Structural Steelwork (FSS) formula. Since steel is often purchased months before fabrication and shop fabrication generally takes a period of two months before delivery to site, application of the main civil engineering formula would be incorrect (195).

The FSS formula has two indices (shown in Appendix 10) which represent changes in the costs of resources in a similar way to the main civil engineering formula. Recovery of reimbursement by applying the FSS formula is similar to the method described in Section 11.2.2.3 for the main civil engineering formula.

11.2.2.1 PRE-CONTRACT PREPARATIONS

To make the use of the main civil engineering formula binding on both parties to the Contract, the ICE Conditions require that the following should be done:

* the scope of the Contract must be defined;
* the proportions should be stated in the Contract Price Fluctuation Clause (CPFC);
* the use of the formula must be incorporated into the Conditions.

11.2.2.1.1 DEFINITION OF THE SCOPE OF THE CONTRACT

According to the NEDO Guide (195) on the application of the formula, if the Contract contains a structural steelwork element the Engineer before tender should decide on how the price adjustment will be carried out. He should also define the extent of structural steelwork in the Contract where necessary. Three distinct situations may arise:

(i) The Contract has no Structural Steelwork: In this case the main civil engineering formula is to be applied.

(ii) The Contract is entirely for Fabricated

Structural Steelwork, or includes a negligible amount of engineering work: In this situation the FSS formula may be used.

(iii) The Contract is both civil engineering and FSS: The Engineer has two alternatives. Firstly, if the amount of steelwork is a relatively small proportion of the Contract he may use the main civil engineering formula, treating FSS delivered as material and the erection as labour and plant. Secondly, he could treat the different parts of the Contract separately, using the main civil engineering formula for the civil engineering work and the FSS formula for structural steelwork.

11.2.2.1.2 PROPORTIONS FOR THE MAIN CIVIL ENGINEERING FORMULA

Prior to inviting tenders the Engineer must assess a breakdown of the main civil engineering work into the following resources for inclusion in the tender documents:

	ITEM	SYMBOL FOR PROPORTION
(i)	Labour and Supervision	A
(ii)	Plant and road vehicles	B
(iii)	Aggregates	C
(iv)	Bricks and Clay Products	D
(v)	Cements	E
(vi)	Cast Iron Products	F
(vii)	Coated Roadstone & Bituminous Materials	G
(viii)	Fuel for Plant Generally (Derv)	H
(ix)	Fuel for Plant (Gas oil)	I
(x)	Timber generally	J
(xi)	Steel for Reinforcement	K
(xii)	Light Re-rolled Bars and Sections	L
(xiii)	Fabricated Structural Steel	M
(xiv)	Non-Adjustable Element	N

Should a tenderer find the Engineer's assessment unacceptable he may make representations to the office issuing the tender documents. Any agreed revisions should be communicated to all tenderers to ensure parity of tendering. These guidelines follow from general guidelines contained in the *Code of Procedure for Single Stage Selective Tendering* (144) as to appropriate action to take where there is uncertainty on tender information.

11.2.2.1.3 INCORPORATION OF THE METHOD OF PRICE ADJUSTMENT

There are three separate clauses which can be incorporated into the ICE Conditions according to the formula adopted for fluctuations adjustments:

(i) the CPFC,

(ii) Contract Price Fluctuation: Fabricated, Structural Steelwork Clause (FSSC),

(iii) Contract Price Fluctuation: Civil Engineering Work and Fabricated Structural Steelwork Clause or the 'link' clause (CE/FSS).

According to the NEDO Guide (195) the appropriate clause to incorporate into the ICE Form are:

(i) the CPFC where the formula to be applied is the main civil engineering formula,

(ii) the FSSC where the FSS formula is to be applied,

(iii) all the three clauses where both formulae are to be applied.

11.2.2.2 PRE-CONTRACT PROCEDURES: FABRICATED STRUCTURAL STEELWORK

The detailed procedures involved in work with a substantial structural steelwork element have not been covered by this research. The reason for not doing so is that the System to be developed is to apply general civil engineering work.

11.2.2.3 PRICE ADJUSTMENT PROCEDURES

The CPFC describes the method by which the calculations for price adjustment may be carried out. The calculations are done in the following steps:

(i) Determination of the 'Effective Value':
The term 'Effective Value' is defined in the CPFC. Simply stated, it is the total value of adjustable work executed during the Valuation Period. Items based on actual or current costs such as nominated sub-contractors, and some dayworks assessed at current costs are excluded. Abrahamson (133) argues that where dayworks are assessed at tender rates they should be part of the adjustable work.

(ii) Calculation of the Price Fluctuation Factor:
The CPFC describes the formula for calculating the Price Fluctuation Factor. It is stated by the NEDO Guide (195) as:

$$PFF = A \times \frac{(LAc - LAo)}{LAo} + B \times \frac{(PLc - PLo)}{PLo} +$$

$$C \times \frac{(AGc - AGo)}{AGo} + \ldots + \frac{L \times (SSc - SSo)}{SSo}$$

where

PFF = the Price Fluctuation Factor which is used to multiply the Effective Value to arrive at the amount of the increase or decrease under the clause,

A,B,C, etc = coefficients representing the proportionate value of items covered by the indices determined by the Engineer and inserted in the tender documents.

LAc, PLc, etc = Current Index Figures

LAo, PLo, etc = Base Index Figures.

(iii) Determination of Net Adjustment

The additional amount to be paid, or recovered from the Contractor due to inflation is the product of the results obtained under (i) and (ii).

An example to illustrate the calculations involved is given in the NEDO Guide (195) on the application of the civil engineering formula.

11.2.2.4 CONSIDERATIONS IN DETERMINING PRICE ADJUSTMENTS

During the assessment of adjustments, attention is usually paid to the following considerations:

11.2.2.4.1 VARIATIONS

New items priced at Bill rates or on the basis of Bill rates are to be included in the relevant Effective Values whereas variations valued at current prices should not. This follows from the definition of Effective Value in the CPPC.

Normally no adjustment should be made to the index weightings. However, the NEDO Guide (195) states that if a significant change in the scope of the work occurs, both parties may agree to either (i) revised weighting for the whole Contract or (ii) new weightings for that part which changes the scope of the project.

11.2.2.4.2 UNFIXED MATERIALS AND GOODS

Amounts in respect of unfixed materials are to be excluded from adjustment. This is because payment for such materials are usually calculated on the basis of their invoiced costs as discussed in Chapter 9.

11.2.2.4.3 CLAIMS

Where claims are quantified on the basis of Bill rates their amounts accepted for payment are subject to price adjustment. They are not adjustable when valued at current costs. These conclusions follow from the definition of Effective Value in the CPFC.

11.2.2.4.4 PROVISIONAL INDICES

Indices for any month when first published are provisional. Usually firm indices are published when sufficient information necessary for their accurate calculation become available. The calculation of the amounts of adjustment will also be provisional initially and will be subject to revision when the next valuation following the publication of the firm indices is done.

11.2.2.4.5 SUB-CONTRACTORS AND SUPPLIERS

The main civil engineering formula has been designed for use in contracts between the client and the main contractors and as such covers, on a weighted basis, the total labour, materials and plant content of the contract. It follows from this therefore that it is not usually appropriate to use on the same basis between the main contractor and sub-contractor where possibly only one main material is involved and the weighting of labour and material for the sub-contract work may be different from that of the main contract.

However, according to the Guide (195), if it is possible to use one or more of the indices appropriate to a sub-contractor's work on a suitably agreed weighted basis the method could be adopted. Alternatively, the main contractor might agree other methods of reimbursement with his sub-contractor with no regard to the fact that his own reimbursement is on a formula basis.

11.2.2.4.6 WORK EXECUTED AFTER THE DATE OF COMPLETION

In the case of adjustment for the main civil engineering work where the date of completion and the last day of the certificate are later than the due date of completion, it is the Final Index Figure applicable to the date 42 days prior to the due date which applies (sub-clause (2) (c) of the CPFC). The effect is to prevent the Contractor recovering for increases in a period of his own delay. The reverse effect of this limitation is that if prices fall after the due date of completion the Contractor keeps the benefit.

The same principles apply in respect of sections where they are specified for completion before the completion of the whole Contract.

CHAPTER TWELVE

THE CONTRACTOR'S MANAGEMENT FUNCTIONS AND THE FLOW OF INFORMATIONS AMONG THEM

It is discussed in Chapter 3 that there is a wide spectrum of variation in organisation structures among construction companies. It is also apparent from the general literature that there is little standardisation in terms of the tasks undertaken by any particular management function.

This research uses the following re-organisation of the functions listed in Section 3.4.3:

* Estimating,
* Planning,
* Cashflow Forecasting,
* Valuations,
* Cost Control,
* Accounting.

The reasons for the particular re-organisation are, firstly, that they are easily identifiable as the basic building blocks of any other organisation and, secondly, that there is a general tendency to list commercially available software under those functions.

This Chapter provides brief descriptions of the operations, procedures and principles involved in these functions. System's input-output diagrams were constructed from the descriptions and used as a basis for determining the flows of information among the functions.

12.1 PLANNING

The term 'planning' as used in the construction industry appears to mean different things to different people. Pilcher (177) writes that to some people the word is synonymous with the drawing up of construction programs whilst to others it is all the work undertaken by planning departments in construction companies. Cooke (134) also suggests that the procedures involved in planning may vary from company to company. The significance of these differences is that there is a need to adopt a definition of planning in terms of its scope and procedures for the purpose of this research.

The definition of the scope of planning adopted in this research is that of Moder (102) who defines planning as the process of preparing for the commitment of resources in the most economical fashion. The procedures identified from literature reviews (104, 134, 177) are summarized as:

(i) From the Bill of Quantities, drawings, specifications, and Site Visit Report an overall approach to the construction of the project is formulated. This approach is usually drawn up in a Statement of Construction Method which may be broken down into separate Method Statements for key operations.

(ii) A list of activities is then drawn up from the various Method Statements. These activities are then placed in sequence of time,taking into account the requirements that certain activities must be performed sequentially whilst others are performed simultaneously.

(iii) The quanties of the various activities are extracted from the Bill of Quantities and the drawings.

(iv) The cost of labour, plant, materials in each activity is determined from an estimate of its cost.

(v) Durations of each activity are determined from the quantities and resource output/usage constants. Durations are also sometimes determined from experience. A critical path may be determined using networks.

(vi) The durations and inter-relationships of the activities are adjusted to satisfy constraints of time, and company resource availability.

(vii) Various reports are produced for distribution to other project participants. The commonest reports include:

* The Master Program,
* A Schedule of Labour Requirements,
* A Schedule of Materials' Requirements,
* A Schedule of Plant and Equipment Requirements,
* A Schedule of Sub-contractors and Suppliers,
* A Schedule of Information Required from Consultants.

Budgets and cashflow forecasts may also be prepared.

(viii) Detailed Stage programs to cover operations to be undertaken over the succeeding 4 - 6 weeks are prepared. Such short term planning often entails a review of the Master Program.

(ix) Site foremen prepare detailed weekly plans which must agree with the Master Program and the stage programs.

(x) Performance to date is monitored and programs are updated to take into account the progress position and variations.

A data flow diagram constructed from the above description of planning is shown in Figure 12.1.

12.2 ESTIMATING

The main ways whereby a construction contractor can obtain work are (88):

* selective tendering,
* open tendering,
* negotiation.

Whichever of these methods is used, the contractor will usually have to determine the right price at which he should carry out the contract. The task of determining this price is referred to as estimating.

During estimating the contractor is subject to two opposing pressures. On the one hand his price should be so low that he will win the contract

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against his competitors. On the other hand his price should be so high that he makes an acceptable level of profit on it. To walk this tightrope contractors need to evolve systematic procedures for the estimating process. McCaffer and Baldwin (123) describe the following steps involved in producing an estimate:

* programming the estimating task,
* preliminary project study,
* materials and sub-contract enquiries,
* detailed project study,
* calculating labour and plant costs,
* estimating the direct costs of the project,
* calculating on-oosts,
* preparing reports for tender adjudication.

12.2.1 PROGRAMMING THE ESTIMATING TASK

The main objective at this stage is how to schedule the estimating tasks to produce a competitive tender within the tender period. Information which would be essential in drawing up a program include:

* existing construction and estimating work load,
* type of work,
* tender documents.

12.2.2 PRELIMINARY PROJECT STUDY

Information produced by this study include:

* list of principal quantities of work,

* an approximate estimate using known average rates for work items,
* list of work items to be sub-contracted,
* list of materials for which quotations are to be sought,
* list of P.C. and provisional sums,
* list of approved sub-contractors and suppliers,
* outline preliminary construction method and program,
* key delivery dates.

12.2.3 MATERIALS AND SUB-CONTRACT ENQUIRIES

Enquiries are made to prospective sub-contractors and suppliers of materials. Nominated sub-contractors may be vetted with a view to taking advantage of contractual provisions on undesirable nominated sub-contractors.

12.2.4 DETAILED PROJECT STUDY

The preliminary study is carried out further. The project site is visited and a report of findings prepared. Consultations among various functional groups are carried out. Sub-contractors and suppliers are selected tentatively after sub-contract and materials quotations are chased, collated and reviewed.

Information produced at this stage include:

* a statement of general method of construction,

* detailed method statements for the various operations,
* a pre-tender construction program,
* a list of major resource requirements,
* a list of sub-contractors and suppliers to be engaged.

12.2.5 CALCULATING LABOUR AND PLANT COSTS

This stage involves the calculation of 'all-in-rates' for labour, and plant resources. 'All-in-rates' refer to all the costs incurred by the Contractor as a direct result of employing labour or using the item of plant. Details of the calculations involved in labour 'all-in-rates' are provided in the 'Code of Estimating Practice' (107).

12.2.6 ESTIMATING DIRECT COSTS

This involves the following tasks:

(i) The prices of materials contained in quotations from suppliers are adjusted for wastages, additional costs for handling and storage and other losses.

(ii) Sub-contractors' quotations are adjusted for attendances.

(iii) The quantities of each resource required for the various work items are determined. A knowledge of usage rates of materials and of output rates of labour and plant is required at this stage. Such information is contained in the method statements.

(iv) A dayworks schedule is produced.

(v) Charges on PC sums are assessed.

12.2.7 CALCULATING ON-COSTS

On-costs are defined in Section 8.6.1. The work and services involved typically include:

* site management and supervision,
* plant,
* transport,
* scaffolding,
* miscellaneous labour,
* accommodation,
* temporary works,
* general items,
* commissioning and handing over,
* sundry requirements.

On-costs are usually isolated in a preliminaries bill in the case of building contracts whilst with civil engineering work they may be Method-related Charges in work items section of the BOQ.

Various reports are prepared for adjudication of the tender by senior management. Information contained in the report typically include:

* a description of the project,
* a general method statement,
* market and industrial conditions,
* the state of the design,
* unusual risks,
* major assumptions of the estimate,
* BOQ analysis:
  . contractor's labour, plant and materials,
  . domestic sub-contractors to be engaged,
  . sums for nominated sub-contractors,
  . sums for nominated suppliers,
  . sums for attendances,
  . provisional sums,
  . a priced BOQ containing a breakdown of each rate into costs of labour, plant, materials, sub-contractors and overhead.

12.2.8 TENDERING

The estimate is evaluated and adjustments made for general overheads, risks, market conditions and profit.

The flow of information is shown in Figure 12.2.

INPUT

- General Contract Information →
- Tender BOQ →
- Specifications →
- Sub-contractors' Information →
- Suppliers' Information →
- Pre-Tender Program →
- Employees Register →
- Company Plant Register →
- Company Resources Cost Data →
- Contract Resources Cost Data →
- Method Statements →
- Quotations →
- Labour output rates →
- Plant output rates →
- Materials usage rates →
- Materials Wastage Factors →
- Unit/standard costs →
- Schedule of average rates →
- General Dayworks Schedules →
- Site Visit Report →
- Site Organisation →
- Management Accounting Information →
- Past Balance Sheets →
- Past Profit & Loss Accounts →
- Project Cashflow Forecast →
- Company Cashflow Forecast →
- Company's cost of capital →
- WBS →
- Materials Usage Report →
- Cost Statements →

FUNCTION

ESTIMATING

OUTPUT

- → BOQ
- → BOQ Build-ups
- → Analysis of the BOQ
- → Contract Dayworks Schedules
- → Take-off data
- → Preliminaries Budget
- → Resource Reconciliation
- → Corporate Resources Costs Data
- → Contract Resources Costs Data
- → Schedule of average rates
- → Unit/standard costs
- → Labour output rates
- → Plant output rates
- → Materials Usage rates
- → Materials Wastage Factors
- → Budgeted Profit & Loss QAccount
- → Budget Balance Sheet

Figure 12.2: Information Flow Diagram For The Estimating Function.

12.3 CASHFLOW FORECASTING

A construction contractor is usually paid for work done after he has already incurred commitments to pay for labour, plant, materials and sub-contractors used in executing the work (83, 123, 155). This delay between the expenditure on resources and the payment for work done implies that the contractor has to find capital to finance these short-term commitments. The relationship between the cost liabilities incurred by the contractor and the monies coming into the company is usually referred to as cashflow which is defined by Harris and McCaffer (83) as the transfer of money into and out of the company.

The crucial importance of cashflow to the operations of a company was highlighted by Lord Denning's (109) reference to it as the lifeblood of the construction company. In the first place, failure to obtain finance to meet the adverse cashflow leads to insolvency even though the company might be in profitable circumstances. Very often insolvency can lead to bankruptcy or liquidation. Insolvency is a particularly acute problem among small firms which are in the majority in the construction industry. In the second place lack of funds to finance the operations may restrict the company's ability to take on new work or to expand.

The need to assess capital requirements at both the project and corporate levels is therefore of paramount importance. Such assessment is usually called cashflow forecasting.

Cashflow forecasting involves the following basic tasks being carried out for each project, on-going or expected to be won:

* the determination of the value/time profile, where value is the anticipated earnings of the contractor from the project,
* the determination of the cost liability/time profile,
* the determination of the cash out/time profile,
* the determination of the cash in/time profile,
* the calculation of financing charges.

These tasks are usually carried out in the following steps which are described in detail typically by Harris and McCaffer (83), Cooke and Jepson (155) and McCaffer and Baldwin (123):

(i) The value/time profile is determined by any of the following methods:

  * summing up the values of activities in a construction program,
  * use of a standard s-curve for projects of that type,
  * assuming that one quarter of the contract value will be earned in the first third of the contract program, one half in the middle

third and the remainder in the last third of the program.

(ii) The cash in/time profile is determined by adjusting the value/time profile for the interval between measurements, delay between certification and cash receipts, and retention conditions.

(iii) The cost/time profile is determined by any of the following methods:

* scaling down the value/time profile using the assumption that the cost of each item of work is a constant proportion of its value,
* taking cumulative costs from a construction program and the following estimating data:
  . Bill items in each activity,
  . the breakdown of each bill rate into direct costs and overheads/profit.

(iv) The overall cost/time profile is broken down into cost/time profiles for labour, plant, materials and sub-contractors by any of the following methods:

* using general percentages as the proportions of the resources in the total value/time or the total cost/time profile,
* using the breakdown (labour, plant, materials, sub-contract costs) of activities in a construction program.

(v) The cash out/time profiles for labour, plant, materials, and sub-contractors are constructed from their corresponding cost/time profiles by making allowances for delays between incurring the cost liabilities and actually making payments,

(vi) The cash out/time profiles constructed in (v) are aggregated into a total project cash out/ time profile.

(vii) The cost of financing the project is determined from the total cash out/time and total cash in/ time profiles and the company's cost of borrowing.

The cashflows of the individual projects are aggregated into a corporate cashflow which together with the individual cashflows may support any of the following management actions:

* not taking on a new contract if, when the contract is included in the corporate cashflow, the company's projected cash requirements exceed its overdraft limits,
* renegotiation of overdraft limits,
* the adjustment of the work schedules of existing contracts,
* the negotiation of suppliers' credit.

The flow of data for the cashflow forecasting is shown in Figure 12.3.

INPUT		FUNCTION		OUTPUT
General Contract Information	→			
Supply Contracts Information	→			
Sub-contractor Information	→			
Quotations	→			
Company's cost of capital	→			
Pre-tender Program	→			
Master Program	→		→	Project Cashflow
S-curves of past projects	→	CASHFLOW	→	Corporate Cashflow
Bill of Activities	→	FORECASTING	→	Project financing costs
Activity price breakdown	→		→	Corporate financing cost
Program/Progress Schedule	→			
Progress Report	→			
Variations	→			
Analysis of the BOQ	→			
Payment Receipts	→			
WBS	→			
Budgeted Profit & Loss Account	→			
Forecast Costs to Completion	→			

Figure 12.3: Information Flow Diagram For The Cashflow Forecasting Function.

12.4 VALUATIONS

The processes and procedures involved in the valuations function are described in Chapter 5 - 11. Figure 12.4 illustrates the flow of information deciphered from these Chapters.

12.5 COST CONTROL

The nature and role of cost control is described in Chapter 5. Valuations which provides the standards of performance as well as the accomplishments of work items, is described in detail in that Chapter. Thus, though valuations is a management function in its own right it may be viewed as one of two sub-divisions of the cost control function, with costing as the other sub-function.

Costing involves the following principal activities:

* the determination of labour costs of work items from the unit costs of labour and timesheets covering its employment,
* the determination of equipment costs of work items from the unit cost of plant and equipment timesheets,
* the determination of the cost of sub-contracted work by reference to either sub-contractors' invoices or valuations of sub-contracted work on the basis of the appropriate sub-contract,

INPUT

- General Contract Information →
- Sub-contractors' Information →
- Suppliers' Information →
- Sub-contract Information →
- Supply Contract Information →
- BOQ →
- Analysis of the BOQ →
- BOQ Build-ups →
- Bill of Activities →
- Activity price breakdown →
- Contracts Dayworks Schedule →
- Fluctuation indices →
- Specifications →
- Take-off data →
- Drawings →
- Quotations →
- Contract Resources Costs Data →
- Budgeted Profit & Loss Account →
- Budgeted Balance Sheet →
- Labour output rates →
- Plant output rates →
- Materials usage rates →
- Materials Wastage Factors →
- Schedule of average rates →
- Site Measurement Data →
- Variations →
- Plant & Labour Timesheets →
- Invoices (Accounts payable) →
- Payroll →
- Dayworks Sheets →
- Claims Accepted →
- Preliminaries Budget →
- Program/Progress Schedules →
- Progress Reports →
- Purchase orders →
- Materials Deliveries →
- Unfixed Material Inventories →
- Resource Reconciliation →
- Resource Requirements Schedules →
- Valuations of work items →
- Payments on account →
- Miscellaneous payment receipts →
- WBS →

FUNCTION

VALUATIONS

OUTPUT

- → Site Measurement Data
- → Valuations of Work Items
- → Progress Reports
- → Payment Certificates
- → Statements of Retention & of Sub-contractors Valu

Figure 12.4: Information Flow Diagram For The Valuations Function.

* the determination of the cost of materials used,
* the manipulation of the cost data to provide costs of work items, activities, Work Packages, or the entire contract.

Descriptions of the ways of producing the information required for the control of the various resources are provided as follows:

* labour and equipment: Chapter 5
* materials : Chapter 9
* sub-contractors : Chapter 10

The flow of information in the Cost Control function is shown in Figure 12.5.

12.6 THE ACCOUNTING FUNCTION

Accounting involves the systematic collection of a considerable amount of financial data and their subsequent arrangement into forms suitable for a variety of purposes some of which are discussed in Chapter 5. Accounting systems employed within the construction industry are broadly similar to those used in other industries. However there are differences due to factors peculiar to the construction industry. Nedved (101) identifies the following differentiating factors:

* the non-repetitive nature of construction operations,
* the systems of payment (e.g. interim payment and retention),

INPUT	FUNCTION	OUTPUT
Specifications →	COST CONTROL	→ Cost statements
Drawings →		→ Analysis Variances
Employees' Register →		→ Unit/Standard costs
Master Construction Program →		→ Labour & Plant output rates
Sub-contractors' Information →		→ Materials Usage Rates
Sub-contract Information →		→ Materials Wastage Factors
Suppliers Information →		→ Labour & Plant Payrolls
Supply Contract Information →		→ Plant Availability Report
Method Statement →		→ Materials Usage Report
Site Organisation →		→ Materials Buying Margins
Corporate Resources Costs Data →		→ Sub-letting Margins
Contract Resources Cost Data →		→ Cost Value Reconciliations
Contract Dayworks Schedule →		→ Forecast costs to Completion
Management Accounting Information →		
BOQ →		
BOQ Build-ups →		
Analysis of the BOQ →		
Bill of Activities →		
Activity Price Breakdown →		
Variations →		
Labour & Plant Output rates →		
Materials Usage rates →		
Materials Wastage Factors →		
Unit/Standard Costs →		
Valuations of Work Items →		
Preliminaries Budget →		
Program/Progress Schedules →		
Progress Reports →		
Monthly/Weekly Programs →		
Contract Budget →		
Labour & Plant Timesheets →		
Dayworks Sheets →		
Claims Accepted →		
Purchase orders →		
Requisitions →		
Materials Deliveries →		
Unfixed Materials Inventories →		
Invoices (Accounts Payable) →		
Invoices (Accounts Receivable) →		
Disbursement Information →		
Analysis of Variances →		
Cost Statements →		
WBS →		

Figure 12.5: Information Flow Diagram For The Cost Control Function.

* differences in the types of projects undertaken,
* differences in business structures.

Within the construction industry accounting systems may vary from company to company. For instance, in some companies the provision of information for site cost control may be part of the accounting function (101, 153). This type of organisation limits the usefulnesses of the information because, as Nedved (101) so aptly puts it, few engineers understand accounting whilst few accountants are sufficiently knowledgeable about the basics of construction. The tendency in recent times has been to make site cost control function more independent of accounting in terms of the processing of its information requirements (177). Though the accounting work varies from company to company there are some identical aspects. Two main aspects are discernible.

(i) the routine gathering of data on business transactions and their recording in a systematic fashion,

(ii) the provision of business information by analysing the data collected.

12.6.1 GATHERING AND RECORDING DATA

The data collected cover business transactions which either increase or decrease items of assets, liabilities, capital, revenue or expense.

An obvious way of recording a transaction would be to prepare a new balance sheet or profit/loss statement describing the changes brought about by the transaction. However such a procedure would be very cumbersome, especially where there are a large number of transactions. Accountants have found it more convenient to maintain separate records for various items of assets, liability, revenue or expense. Such records are usually called accounts. They are called cost accounts where they cover expenditure. Cost accounts very often constitute a Work Breakdown Structure around which costs are accumulated. The complete set of accounts for a business entity is called a ledger. The ledger may take the form of a bound book with a page for each account, punched cards, or magnetic media.

The main shortcoming of the ledger is that it provides neither all the necessary data at one location nor a chronological record of transactions. This shortcoming is remedied by another document called a journal. Records of transactions are first entered in the journal showing the various ledgers or accounts affected. Subsequently the records are transferred or 'posted' to the appropriate ledger or account.

A single journal to cover all transaction is perfectly feasible. However, for a large firm, the journal may be split into several sections for ease of handling, specialization or convenience. According to Nedved (101) the following type of journals are commonly used:

* the general journal,
* a purchases journal,
* a purchase returns journal,
* a sales journal,
* a sales returns journal.

Similarly the ledger may also be divided into sub-ledgers. The actual division varies from firm to firm, depending on the size and type of business and the information required from the accounting system.

Business transactions may be categorized into the following broad types:

* payroll transactions,
* distursement transactions,
* sales transactions,
* adjustments of accounts.

12.6.1.1 PAYROLL TRANSACTIONS

A payroll is a record of the employees' wages or salaries and of various deductions. The production of a payroll requires timesheets which contain:

* times for which the employees are to be paid,
* the work items to be charged for the times spent,

* the rates of pay applicable to various times for which each employee is to be paid.

The task of compiling timesheets is a part of timekeeping which involves the following basic steps:

* an up-to-date list of employees is maintained;
* either a foreman or a timekeeper prepares the timesheet;
* the timesheet is turned in to a payroll clerk after being coded;
* the timesheets are checked and priced if found correct.

The payroll contain the following information on each employee (101):

* name and/or number of the employee,
* gross earnings,
* bonus,
* gross earnings to date,
* non-taxable additions,
* tax-free pay,
* taxable pay to date,
* tax due/refund,
* deduction,
* net pay
* employer contribution.

A common practice is to have a separate payroll bank account to cover pay cheques issued to employees. During the processing of each payroll its cost figures are recorded in the books by preparing a payroll voucher to support the cheque issued to transfer funds to cover the pay cheques from the general bank account to the payroll bank account.

12.6.1.2 DISBURSEMENTS

Apart from labour costs the contractor's accounting system has to deal with the following:

* materials costs,
* plant rentals,
* charges for the use of contractor's own plant,
* sub-contractors' costs,
* cost of fixed assets such as plant and buildings,
* miscellaneous expenses.

These costs usually become payable upon the receipt of an invoice detailing the cost liability. However these invoices must be supported by adequate evidence before money is disbursement. Coombs and Palmer (153) identify the following basic evidence required:

* evidence that the goods or services were ordered on proper authority or that the cost

was properly incurred,

* evidence that goods or services were actually received,
* evidence that the prices and discounts are correct,
* evidence of authority to make the disbursement.

In the case of materials and capital equipment such evidence is contained in requisitions, purchase orders, and delivery tickets. On sub-contractors' invoices the sub-contract takes the place of the purchase orders and the computations covering the sub-contract payment application take the place of delivery tickets. Invoices for equipment rentals have to be supported by the plant hire agreement, plant timesheets and site plant inventories. Charges for the use of internal plant have to be supported by plant cost data, plant timesheets, plant allocation sheets and site plant inventories.

The invoices are usually coded to show the general ledger and cost ledger to be affected by subsequent transactions. The invoices are then entered in the appropriate book - journals, ledgers or cost accounts. Further paperwork is often required before payment on invoices are made. Such paperwork indicates the source of money and provides the contractor with tools to prevent double payments for the same goods or services.

12.6.1.3 SALES

The main sources of income for the construction contractor are payment certificates issued by architects/engineers which become accounts receivable once issued. Aside from payment certificates construction companies derive income from other sources such as (153):

* work done for others at the jobsite such as sub-contractors,
* equipment rentals,
* sales of used equipment, scrap, and surplus materials and supplies,
* insurance refunds and proceeds of insurance claims,
* discounts earned,
* camp and mess hall receipts,
* repair services rendered.

The starting point of most revenue accounting in the construction company is the preparation of invoices or valuations to employers and customers. Some of the revenue may be as cash receipts. On receiving a payment certificate, the appropriate employer's account is debited and the contract credited with the amount of the certificate. The invoices covering the other sources of income listed above are treated in a similar manner, with accounts for the sources corresponding to the employers' being maintained.

When payments on certificates or invoices are made, they are recorded in the sales journal, cash books and accounts of the employer or customer. It is only at this stage that retentions on certificates are accounted for.

12.6.1.4 ACCOUNTS ADJUSTMENTS

The records of transactions carried out throughout the accounting year will usually have to be adjusted at the end of the period.
Nedved (101) identifies the following types of adjustments:

* adjustments to accounts for profits/losses,
* adjustments to accumulate depreciation of fixed assets,
* adjustments to recognise bad debts.

12.6.2 THE PROVISION OF BUSINESS INFORMATION

Information produced include:

* a balance sheet,
* a profit and loss report,
* a Directors' report,
* accounts payable reports,
* accounts receivable reports,
* labour cost statements,
* materials cost statements,
* equipment cost statements,
* monthly statements of the state of the

business showing:

. current ratio (current assets/current liabilities),

. acid ratio (cash + debtors/current liabilities),

* profitability ratios,

* operating ratios:

  . percentage for site overheads on turnover

  . percentage for general overheads on turnover

* productivity ratio:

  . asset ratio,

  . investment ratio.

The flow of information for the Accounting function is illustrated in Figure 12.6.

12.7 INFORMATION FLOW ANALYSIS

The flow of information among the management functions is shown in Table 12.1, from which the following observations can be made:

* some functions use common data from common sources,
* some functions provide data to others.

It is therefore very obvious that though the functions are carried out in isolation as discussed in Chapter 3, they are in fact intrinsically integrated in terms of the sources and usage of information.

The analysis of the flow of information also brings out the following two features:

The flow of information for the Accounting function is illustrated in Figure 12.6.

INPUT

- General Contract Information →
- Employees' Register →
- Sub-contractors' Information →
- Suppliers' Information →
- Resource Reconciliation →
- Resource Requirements Schedule →
- Corporate Resources Costs Data →
- Contracts' Resources Costs Data →
- Labour & Plant Timesheets →
- Labour & Plant Payrolls →
- Purchase Orders →
- Requisitions →
- Delivery Notes →
- Invoices (Accounts Payable) →
- Payment Certificates →
- Invoices (Accounts Receivable) →
- Sub-contracts' Information →
- Supply Contracts Information →
- Payment of Certificates →
- Miscellaneous Payment Receipts →
- Contracts' Cashflows →
- WBS

FUNCTION

ACCOUNTING

OUTPUT

- → Budgets:
  - Profit & Loss Accounts
  - Balance Sheet
  - Cash
- → Payrolls
- → Contract Cost Reports
- → Labour Cost Reports
- → Plant Cost Reports
- → Material Cost Reports
- → Assets Register
- → Cheques Register
- → Accounts Receivable
- → Accounts Payable
- → Asset Depreciation Report
- → Management Accounting Information:
  - current ratios
  - acid ratio
  - profitability ratio
  - on-costs as % of turnover
  - Head Office overheads as % of turnover
  - profit as % of turnover
  - asset ratios
  - investment ratios

Figure 12.6: Information Flow Diagram For The Accounting Function.

TABLE 12.1: Analysis of the Flow of Information Among the Functions.

(F - Planning, E - Estimating, CF - Cashflow Forecasting, CC - Cost Control, V - Valuations, A - Accounting, O - X - originating from outside and received by X function).

INFORMATION	ORIGIN	FUNCTIONS WHICH USE IT
General Contract Information	O-E	P/E/CF/V/A
Drawings	O-E	P/E/V/CC
Specifications	O-E	P/E/V/CC
Sub-contractors Information	O-E/O-A	P/E/V/CC/A
Suppliers Information	O-E/O-A	P/E/V/CC/A
General Dayworks Schedule	O-E	E
S-curves of past projects	O-E/O-CF/O-V/V	E/CF/V
Supply Contracts' Information	E/A	P/E/CF/CC/V
Sub-contracts' Information	E/A	P/E/CF/CC/V
Employees' Register	A	P/E/CC/A
Assets Register	A	P/E
Corporate Resources Costs Data	E	P/E/CC
Schedules of Average Rates	E	P/E/V
Plant Inventory	A	P
Plant Allocation	P	P
Pre-Tender Program	P	E/CF
Master Construction Program	P	CF/CC
Monthly/Weekly Programs	P	CC
Site Organisation	P	E/CC
WBS	P	P/E/CF/CC/A
Site Visit Report	P/E	P/E
Resources Requirements Schedule	P/E	P/E/V/A
Resources Reconciliation	P/E	P/E/V/A
Sub-contractors & Suppliers Schedules	P	V
Method Statements	P	P/E/V/CC
Progress Reports	P/V/CC	P/CF/V/CC
Program/Progress Schedules	P/V/CC	P/CF/CC
Bill of Activities	P/CF/V/CC	P/CF/V/CC
Activity Price Breakdown	P/E/CF/CC/V	P/E/CF/V/CC
Contract Budget	P/CC	CC

TABLE 12.1: (Continued).

INFORMATION/DATA	ORIGIN	FUNCTIONS WHICH USE IT
Quotations	E/A	P/E/CF/V
Plant output rates	E/CC	P/E/CC/V
Labour output rates	E/CC	P/E/CC/V
Materials Usage rates	E/CC	P/E/CC/B
Materials Wastage Factors	E/CC	P/E/CC/V
Contract Resources Costs Data	E	E/P/CC/V
Budgeted Profit & Loss Account	A/E	E/CF/V
Budget Balance Sheet	A/E	E/V
Management Accounting Information	A	E/CF/V/CC
Unit/Standard Costs	E/CC/A	P/E/V/CC
Contract Cashflow Forecast	CF	E/V/A
Corporate Cashflow Forecast	CF/A	E/A
BOQ	E	P/V/CC
BOQ Build-ups	E	P/V/CC
Analysis of the BOQ	E	CF/V/CC/A
Preliminaries Budget	E/V/CC	E/V/CC
Contracts Dayworks Schedule	E	V/CC
Take-off Data	E	E/V
Variation Orders	O-V	P/CF/V/CC
Valuationsof Work Items	V	P/V/CC/A
Unfixed Materials Inventories	V	P/V/CC
Dayworks Sheets	V	V/CC
Sub-contractors invoices	V	V/CC/A
Fluctuation indices	O-V	V/CC
Claims accepted	O-V	V/CC
Materials Deliveries	A	P/V/CC/A
Payment Certificates	V	A

TABLE 12.1: (Continued)

INFORMATION/DATA	ORIGIN	FUNCTION WHICH USE IT
Statement of Retention & of Sub-contractors' Values	V	A
Labour/Plant Timesheets	CC	V/CC/A
Purchase Orders	A	P/A
Requisitions	A	CC/A
Cost Statements	CC	CC/A
Analysis of Variances	CC	CC/A
Cost Value Reconciliations	V	CC/A
Materials Usage Report	CC	E
Materials Buying Margins	CC	E
Sub-letting Margins	CC	E
Labour & Plant Payrolls	A	CC/A
Plant Availability	CC	PM
Forecast Costs to Completion	CC	CF
Invoices(Accounts Payable)	O-A	V/CC/A
Invoices(Accounts Receivable)	A	CC/A
Disbursement Information	A	
Payment on Certificates	A	V/CC/A
Miscellaneous Payment Receipts	A	CF/V/A
Past Profit & Loss Accounts	A	V/A
Past Balance Sheets	A	V/A
Asset Depreciation Report	A	A
Cost of Borrowing	A	E/CF/V/A

(i) The data provided by any function is, in the majority of cases, insufficient for the needs of the receiving functions and would have to be supplemented by data from other functions. For example, the cashflow forecasting function needs data from both estimating and planning to derive the value/ time profile.

(ii) The data provided is not always in a format appropriate to the needs of the receiver. For instance, the BOQ usually has to be rearranged into activities for planning, valuations and cost control.

To achieve integration with manual systems would entail mind-bogglingly tedious data retrieval and calculations. The use of computers, with their enormous data storage and retrieval, and computational capabilities, should therefore make integration more practicable.

However the use of stand-alone systems would not allow the maximum level of integration because of the following disadvantages:

* costly data capture,
* long turn around times,
* poor management of computer resources,
* inconsistency,
* inflexibility

12.7.1 DATA CAPTURE

The task of collecting data external to the computer system into it is called data capture (23). Typical systems for data capture include on-line terminals (video and hard-copy), punched cards, and paper tape. Data preparation involves preparing the data for ease of entry into the computer system and can be a formidable. The Design Office Consortium (now the Construction Industry Computing Association) (4) found that for many systems it surveyed, the cost of data preparation ranged from one to four times the cost of computing. Integration of the independent systems would allow several systems to share common data inputs as well as pass data to others. Other problems relating to data capture include increased risk of errors and increased programming effort with stand alone systems.

12.7.2 TURN AROUND TIME

Many tasks are repeated many times during a construction contract. An example is the requirement of planning updates. A probable reason why this is not done often may be, not only the cost of data capture, but also the fact that data capture may take so long that the revised plans are out of date by the time they are ready.

12.7.3 POOR MANAGEMENT OF COMPUTER RESOURCES

Data required by several systems would have to be provided as separate files if they are stand alone. For instance, resource costs data files would have to be provided for each of the stand along systems for Estimating, valuation, planning and cost control. The resulting duplication of data is potentially dangerous to their integrity. Identical data items having different values and inconsistent updating policies can lead to conflicting reports.

12.7.4 INCONSISTENCY

Stand alone systems can create inconsistencies in policies and operations, e.g. the breakdown of work for costing purposes according to pre-defined accounts codes may be quite inconsistent with the way the work will be physically done and could lead to problems for management in reconciling cost status and progress status.

12.7.5 INFLEXIBILITY

Stand alone systems are often cumbersome when implementing changes. In addition, though the information for answering certain questions may be contained in the various systems, the questions may be unanswerable from any one of the systems.

12.8 THE USE OF A SUITABLE WORK BREAKDOWN STRUCTURE

Two aspects of a Work Breakdown Structure are considered:

(i) the concept,

(ii) its relevance to integration.

12.8.1 THE CONCEPT OF A WORK BREAKDOWN STRUCTURE

Projects have always been implicitly structured in one way or another. This is evidenced by such terms as cost centers, work packages, and cost accounts. With the increasing complexity of projects the concept of the Work Breakdown Structure (WBS) has crystallized a more formal and systematic way of defining and identifying the components of projects. The WBS may be defined as a hierarchical method of breaking down a large project into a family tree of services and work items required to produce the end product (105).

The WBS is constructed by exploding the project into its component parts and services required, with each of these components being further subdivided into lower level elements. This explosion is continued until the project is fully defined in terms of 'what' is to be done to complete the projects. The WBS therefore allows the larger projects to be treated as a hierarchy of portfolios of smaller projects, each with defined respoñsibility. Although the concept is primarily applicable and essential to the larger projects, it is also useful in the management, planning and control of smaller projects (26). Projects of lesser complexity, or size, may require fewer levels of work break-down.

It was observed in this research that construction management literature is lacking in the conceptual basis of the WBS. The term 'Work Breakdown Structure' is rarely even used though three basic levels of the WBS described are identifiable:

* Bill items,
* activities,
* Work Packages.

Their structure is described in Figure 12.7.

12.8.2 THE RELEVANCE OF THE WBS TO INTEGRATION

Sharing data electronically alone is not enough to achieve effective integration. There must be, in addition, a uniform and consistent system of communication whereby the data input into, or produced by the various functions can be sorted and reported to all parties on a common basis. For example, the values of a work item produced by the valuations function and its costs determined by the cost control function

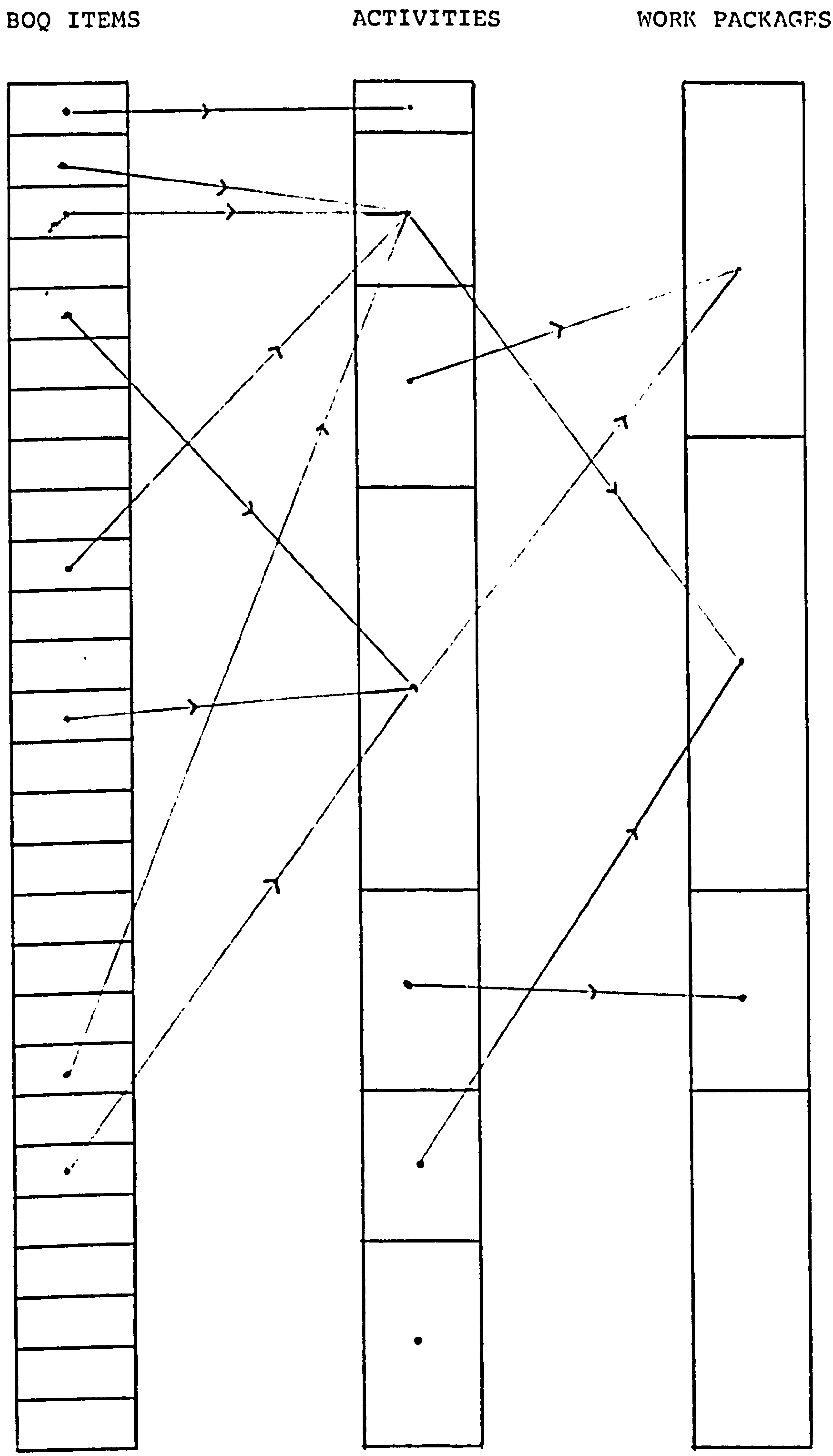

Figure 12.7: Typical Construction Work Breakdown Structure

must be allocated to the same work packaoe if the comparison of the values and costs is to produce meaningful information. Failure to do that would be analogous to two individuals talking to each other in mutually incomprehensible languages.

Apart from being used to define the work required to complete a project and allocate responsibility for all work, the WBS also serves as the system of communication among the functions. Just as a common language is essential for effective communication in ordinary everyday human interaction, the use of a common WBS is a necessity for effective integration of the management information. This requires that all functions allocate parameters (e.g. estimates, budgets, cost and variances) of BOQ items to the corresponding parameters of the same activities. The same requirement apply to higher levels of the WBS (e.g. activities and work packages).

The requirements of a suitable WBS are that:

(i) it is so simple that it can be easily understood by all those expected to use it (177);

(ii) it must be such that each level is significant and meaningful, both from a data collection and overall reporting point of view (105).

Data on production at site are usually collected by workmen who are not expected to understand the nitty gritty of contract management information. The activities, work packages and the coding systems should therefore be designed with the limitation of the workmen in mind.

A company management information system serves several levels of management. Identifiable levels of management on construction contracts include:

* site supervision level,
* individual contract management level,
* head office contracts divisional level,
* company top management level.

The level of detail of input data and/or reports at any level should be appropriate to its decision-making processes. On the one hand too much detail leads to mistakes in the allocation od costs by workmen whilst on the other hand too little detail would render the information system ineffective (177). According to Harris and McCaffer (83) about 15 work packages at the supervisory level would be satisfactory.

12.9 THE INFLUENCE OF THE ANALYSIS IN THE DESIGN OF PLUS VAL

The results of the analysis of the flow of information among the functions and the examination of the role of the WBS were embodied in the design of PLUS VAL. Aspects of the design that were influenced and which constitute the basis of its facilities for integration include:

* data modelling,
* file structures,
* procedures supported,
* output produced.

12.9.1 DATA MODELLING

Data consists of symbols which represent, describes or record reality but these symbols are not the same as reality. For instance, a name identifies a person, but the name is not the same as the person. Decisions about what to extract from reality and how to represent it using symbols should therefore reflect the needs and views of the users of the data. For a Bill item the planning function is interested in the activity to which it belongs, whereas the cost control function is concerned more with its work package.

Humans input huge amounts of data into

their brains, but data are not stored as individual items. They are categorized and related to other data items already stored. The same concept is applied to computer storage; data to be stored must be categorized and related to other data.

The information flow analysis and the examination of the application of the WBS (work packages being made of activities which are in turn built up from Bill items) provided the framework for understanding the structure of data items as they relate to the organisation and data users in construction. This understanding was then expressed as data models. An example is provided by PLUS VAL'S model of the BOQ, which consists of the following items of data:

* Bill number/section,
* page number,
* item number,
* description,
* unit of measurement,
* unit rate,
* rate breakdown,
* total quantity,
* total amount,
* quantities completed during each valuation period,
* activity to which it belongs,
* Work Package to which it belongs,
* Work Category for price adjustment,

* type of treatment as regards retention,
* resource build-ups.

Obviously, this is a far more general view of the BOQ than is customary with the individual functions who have to deal with the BOQ in one way or another. The analysis allowed all other data, stored by PLUS VAL to be related in a manner similar to the BOQ data. Figure 2.4 shows an outline of the flow of data involved in PLUS VAL whilst details of the data models are provided in Chapter 13.

12.9.2 FILE STRUCTURES

There are two major classes of data models - logical data models and physical data models (200). These two classes reflect the fact that efficient physical storage and retrieval of data must be designed around the physical characteristics of storage media and devices, but users of data should be able to describe, think about, and use data without being concerned about its physical storage. The user-oriented ways of describing and understanding data are termed logical data models or user views; the models that describe physical storage of data are physical and data models, or physical views (200). The two data models reflect an ideal separation of how data is used from how data is stored and accessed. Ideally, changes in storage technology should be possible without affecting applications using the data.

The analysis of the flow of information among the functions produced the logical models required for the design of the physical models. For instance, PLUS VAL'S files for activities allow storage space for standard manhours and bonus targets even though such data are not required by valuations. The effect is that it is easier than otherwise to integrate PLUS VAL with a module for bonus calculations as the files do not have to be modified for that purpose. This approach is reflected in the entire design of PLUS VAL.

12.9.3 PROCEDURES SUPPORTED

The information flow analysis revealed that certain procedures are supposed to be undertaken by other functions but that the valuations function needs the data produced thereby. An example is the construction of the bill of activities described in Section 6.2.2. Wherever this was found to be the case PLUS VAL was specified to support the procedures. As the inclusion of such procedures in the specifications of other functions would be unnecessary, this feature is yet another nail in the coffin of non-integration.

12.9.4 OUTPUT PRODUCED

The analysis also revealed that even though the valuations function assembles and maintains the data required to produce certain identified information, the production of such information is not customarily its responsibility. An example is valuations against work packages which are part of the cost control function. Where these two functions are exercised by different persons the information can be rendered wrong, or inaccurate by unavoidable imperfections in the transfer of data and relevant knowledge.

PLUS VAL was designed to produce this type of information in addition to the information customarily required of the valuations function.

CHAPTER THIRTEEN

SYSTEMS SPECIFICATION

In chapter 2 it was discussed that system analysis involves determining and examining the procedures and processes involved in the existing systems, deciding what changes and new features are needed and then defining exactly what the new system will do. The existing systems for carrying out valuations and the various other control functions are described in Chapter 5 - 12. A specification of a computer-based system was drawn up from the findings of the investigations described in those chapters.

This chapter contains a summary of the Systems Specification.

13.1 GENERAL SYSTEM'S OBJECTIVE

The primary objective of the System is to carry out the following functions for contracts based on the JCT and ICE standard and their amended forms:

(i) external valuation (interim and final accounts),

(ii) internal valuations,

(iii) progress reporting,

(iv) the provision of information for the control of materials, purchasing and sub-contractors,

(v) the provision of yardsticks of earnings

structured along Work Packages or Cost Centres against which corresponding costs incurred or accruing may be compared for the purpose of taking corrective action whenever necessary,

(vi) integration of project information.

13.2 SPECIFICATION OF FEATURES OF USER INTERFACES

Chapter 4 contains an overview of important features of user interfaces and of how they should be selected for any particular situation. This section summarizes those of the features considered desirable for this particular application.

(i) USERS: The system should be designed for people possessing skills customarily required in their current jobs. This means that users should not be expected to have prior knowledge of computers or of computing. Details of this requirement are contained in Section 4.1 of Chapter 4.

(ii) HARDWARE (Section 4.3 of Chapter 4)

Typical hardware configuration should comprise:

* computer,
* QWERTY keyboard,
* video display terminal,
* printer.

The system should be so designed that it can be implemented on a variety of hardware configurations without major adjustments. Considerations which should be taken into account in selecting any particular hardware configuration are:

* ergonomic factors;
* corporate policy on hardware acquisition;
* the likelihood of the manufacturer staying in business for a sufficient length of time;
* value for money.

(iii) FUNCTIONS: The system should assist all functions necessary to carry out the objectives in Section 13.1.

(iv) SYSTEMS DIALOGUE (Section 4.4.2 of Chapter 4): The system is to be menu-driven and interactive. Provision should be made to 'turn-off' some menus and for implementing the system as a command- or forms-driven one in the future. Dialogue should avoid computer science jargon and should employ construction management terminology as far as possible.

(v) SCREEN DESIGN (Section 4.4.2.2 of Chapter 4):

* Displays of information on screen should be clear, uncluttered and free of irrelevant information.
* Only information that is essential to making a decision or performing an action

should be displayed.

* All data related to a task should be provided on a single screen.

* The user should not have to remember data from one screen to the next.

* The most important data should stand out.

* Guidance must be available on the screen (preferably at the bottom) if required.

(vi) FEEDBACK AND ASSISTANCE (Section 4.4.2.3 of Chapter 4):

* The system should acknowledge every user request in some way. For instance, when the system comes to the end of a task without any visible sign of that, there should be a message informing the user that the task has been completed.

* Additional assistance should be available whenever it is likely to be required.

(vii) ERROR CONTROLS (Section 4.4.2.4 of Chapter 4): The incidence of human errors in the information dialogue should be minimised. The following dimensions of error control should be provided:

* prevention,
* detection,

* correction,
* recovery.

(viii) RESPONSE TIME (Section 4.4.2.5 of Chapter 4):

The design should meet the following requirements:

* response time of about one second for simple requests,
* response times for a given request should be as consistent as possible,
* if a response will take a long time (say greater than 10 seconds) a message should be issued within 1 to 2 seconds to give the user feedback.

(ix) MULTI-USER (Section 4.5.2 of Chapter 4):
The system should be capable of supporting several users and contracts.

(x) SECURITY: Only authorized personnel should have access to facilities, applications, and data. This should go a long way in allaying the anxieties of functional groups discussed in Chapter 3.

(xi) REPORTS (Chapter 1 and Section 4.2 of Chapter 4):

* The most important items should be easiest to find,
* All pages should have a title and page number and should be dated,
* Whenever reports are required they should

first be prepared and held in computer files which the user may print. One of the drawbacks of currently available software as discussed in Chapter 2 is that they produce too many useless printouts. Allowing for the user to positively identify which reports he wants printed should redress the situation.

* The reports and their output should be relevant to the actions and decisions to be taken (Section 4.2 of Chapter 4),

* The various output should be available in time for actions and decisions. (Section 4.2 of Chapter 4).

(xii) FLEXIBILITY AND VERSATILITY: It has been discussed in Chapters 2 and 3 that different companies operate differently and even with the same company methods of operating may vary from time to time and from project to project. The system should therefore be built with flexibility and versatility in mind.

(xiii) In Chapter 3 it was discussed that it may not be advisable for a company to start using computers by acquiring sophisticated systems.

Computerisation of discrete functions may be more advisable in such situations. With the varying degrees of exposure to computers existing among construction companies it is therefore desirable that the system be capable of being implemented as a stand alone system or as a link of an integrated suite of software.

(xiv) PROGRAMMING LANGUAGE: Programming should be in standard ANSI FORTRAN 77. The basis of this choice is discussed in Chapter 2.

(xv) Adequate controls should be built into the system so that it is evident to the user that data is being processed correctly (Section 4.2 of Chapter 4).

(xvi) The system should be in line with traditional practices.

(xvii) MANAGEMENT OF USER RESISTANCE (Section 4.7.1 of Chapter 4).

The following should be provided for:

* training,
* systems support,
* job redesign where necessary,
* persuasion,
* policies where necessary,
* user participation,
* commitment of management.

13.3 SPECIFICATION OF PRINCIPAL OUTPUT

In Chapter 5 it was discussed that a variety of documents are often required to support an external valuation application whilst others are required by the Contractor's organisation to carry out its other functions.

The principal reports identified and which the system should produce are:-

* Up to date Bills of Quantities (i.e. including variations, rearrangements and correction of errors);
* Bill of Quantities containing, in addition, the quantities and values of each Bill item for the following periods:
  . up to previous valuation
  . current valuation period
  . to date
* Bills of activities;
* Priced dayworks sheets;
* Dayworks accounts;
* Dimensions of measured work;
* Resources data;
* Priced list of unfixed materials;
* Build-ups of claims on a 'cost plus' basis;
* summary of claims;
* Bills of variations;
* Fluctuation calculations;
* Interim/Practical Completion/Final Account Payment certificates;

* statements of retention and of sub-contractors' values;
* Internal valuation;
* sub-letting margins;
* Materials' Buying Margins;
* Materials Wastage Report;
* Valuations under heads of labour, plant, materials, sub-contractors, overheads/profit for each work package;

Every report should have the following information printed at the top of the first page:

* project title,
* name and address of client,
* names and addresses of consultants,
* name and address of the Main Contractor,
* contract registration numbers,
* Date of Commencement.

This information is designed to minimise the problems of reports of different contracts getting mixed up.

13.4 GENERAL SPECIFICATION FOR INPUT

The design features of input are discussed in Section 2.3.2.3 of Chapter 2. Those of them considered applicable or desirable in this system are:

(i) the method of inputting data into the system should be either by means of typing at a keyboard or entry through a magnetic disk;

(ii) as much as possible all numeric data entered through a terminal must be in free format, i.e. the form in which they would normally be written in ordinary everyday usage;

(iii) the amount of input should be the minimum possible to carry out the System's functions;

(iv) data input process should be simple;

(v) all variable data entered at the terminal must be verified and confirmed.

13.5 SPECIFICATION OF STORAGE

The System should allow for the storage and maintenance of the following categories of data and information which are described in detail below:

* Contract's general information,
* Sub-contractors' information,
* data from the BOQ,
* build-up data for Bill items,
* resources' data,
* data on claims,
* data on dayworks,
* Dayworks Schedule,
* data on unfixed materials,
* data on sections,
* data on Work Packages,

* data on purchase orders,
* data on suppliers,
* data on delivery of materials,
* NEDO indices for both building and civil engineering contracts,
* data on variations.

13.5.1 CONTRACT'S GENERAL INFORMATION

The System should allow the storage and maintenance of the following information which can be compiled from the Contract Documents:

* Project Title,
* name of Client,
* address of Client,
* contact person of Client,
* Client's telephone number,
* name of Consultants,
* address of Consultants,
* contact person of Consultants,
* telephone number of Consultants,
* name of Main Contractor,
* address of Main Contractor,
* Contract Registration Number,
* form of contract,
* date of commencement,
* date of completion,
* Tender Total/Contract Sum,
* percentage retention,

* limit of retention,
* minimum amount of interim payment,
* liquidated damages per week,
* minimum amount of insurance,
* Bond as percentage of Tender Total/ Contract sum,
* Base month for fluctuation calculations,
* proportions for CPFC as discussed in Chapter 11.
* reference numbers of documents containing the general method statement of the contract.

Some of the data above may be required on a day-to-day basis for general communications between the various parties. The importance of establishing proper channels of communication has been discussed in Chapters 7 and 8. The storage of such data allows for updating of the system to take account of technological improvements already on the horizon such as electronic mail and automated offices. The storage of such information will also overcome the problem of the dispersal of project participants and their personal documents such as diaries.

It is increasingly recognized that getting information at a few strokes of a keyboard is faster and more convenient than rummaging through paper or even human memory.

Some of the information such as the retention details are required for the calculations necessary for valuations. This is discussed in detail in Chapter 5.

It has already been discussed in Chapter 5 that the main limitation of feedback is the fact that very few construction contracts are similar in all respects. The storage of the reference to a document containing a method statement is intended to aid the quick identification of past projects which may hold data relevant to the particular project in hand. For instance, the references could be the file names where all method statements are stored in named files on computer disk.

13.5.2 SUB-CONTRACTORS' INFORMATION

From the description of the control of sub-contractors contained in Chapter 10, the system should allow the storage and maintenance of the following data in respect of each sub-contractor:

* name,
* address,
* contact person,
* telephone number,

* type (domestic sub-contractor, nomimated sub-contractor or statutory authority/undertaker),
* inflation provision (NEDO formula, fixed priced, variation of price),
* identity number.

Some of the above information is required for the purposes of communication. Others are required for calculating payment entitlements. Flagging of Bill items, activities, and resources with the identity number of a sub-contractor allows identification of the sub-contractor's inputs into the project which, in turn, enables the determination of payment entitlements.

13.5.3 DATA FROM THE CONTRACT BILLS OF QUANTITIES

From the discussion of the operations of valuations and cost control in Chapter 5 and the description of the data flows in Chapter 12 it is apparent that data contained in the contract Bills of Quantities are at the heart of the system to be developed and the whole issue of integration. There is therefore a need to store such data on computer files from which data necessary for the valuations and cost control functions may be obtained.

There is a need to store and maintain the following data in respect of each Bill item which will usually be available from the estimate:

* code,
* description,
* unit of measurement,
* Bill quantity,
* unit rate,
* Bill amount,
* Bill section,
* page number,
* item number,

As discussed in Chapter 5, some estimating systems, INTEREST for example, may breakdown the unit rate and Bill amount into their components for labour, plant, materials, sub-contractors and overheads/profit. Where such data is available it is possible to breakdown any valuation into corresponding components for individual items, or predefined parts of the work. Where this is done for Work Packages these components constitute yardsticks against which actual costs incurred on the packages may be compared. Such comparison provides information on performance. It is therefore essential to store the Bill item breakdown where it is available.

Other Bill item data which is not directly relevant to the estimate but which will be required for measurement, valuations and cost control, and therefore should be stored by the System are:

* dimensional type (non-dimensional, linear, superficial and cubic): this is required

when some site measurement is in the form of dimensions of the work measured;

* item type which may be one of the following:
  . preliminaries,
  . provisional sum,
  . PC sum (nominated sub-contractor),
  . PC sum (nominated supplier),
  . statutory fee,
  . percentage addition for attendance on a nominated sub-contractor,
  . percentage addition for attendance on nominated suppliers,
  . percentage profit on PC item,
  . percentage addition for profit on work of a statutory authority/undertaker,
  . percentage addition for attendance on a statutory authority/undertaker,
  . other

  This data is needed if the System is to provide information on payments received on account of:

  . preliminaries,
  . provisional sums,
  . nominated sub-contractors,
  . nominated suppliers,
  . statutory fees,
  . attendances.

  Such information may be required for control purposes or by the client.

* NEDO Work Category for building contracts: This will enable the total earnings for each Work Category to be determined for the purpose of calculating additional payment for price fluctuation;
* price adjustment/no price adjustment for ICE contracts. This allows the total component of valuations subject to price adjustment to be calculated;
* subject to retention/not subject to retention: This allows the total amount of retention to be calculated;
* activity: This allows the data on each activity which is required for valuations based on activities to be determined;
* Work Package: This allows the structuring of valuations against Work Packages.

15.5.4 BUILD-UPS DATA FOR BILL ITEMS

The following data on resource build-ups for Bill items should be stored and maintained:

* resource reference number,
* usage/output rate,
* wastage factors (for materials),
* number of formwork uses (Ø if not a formwork item).

When the quantity of a Bill item completed is known the easy availability of the build-ups allows the quantities of resources which should have been used had the contractor achieved his performance standards to be calculated. By comparing quantities as determined with actual quantities used an assessment of performance may be made

It is discussed in Chapters 5 and 9 that the details of such assessments for labour, plant and materials vary. One of the points raised was that materials are controlled by determining the quantity saved or wasted whilst labour and plant, on the other hand, are controlled by comparing standards with actual performance, usually in monetary terms. Where labour and plant are controlled in this fashion there may be no need to use the build-up data. It has also been discussed that inflation can sometimes make the comparison of the standards and actual financial performance inappropriate unless extensive manipulations are made for such inflation. An alternative to get round this problem is to compare budget quantities of resources and actual quantities expended to reach the stage at hand (160). For instance, instead of comparing labour cost per unit of concrete placed which is historical data with labour cost per unit today it may be more revealing to compare budget man hours against actual man hours. Where the latter approach is adopted the build-ups data will be relevant for the control of all resources.

13.5.5 RESOURCE DATA

From the analysis in Chapter 12 of the flow of data among the operations of the management functions and the description of the valuations, estimating and cost control functions in Chapter 5, it can be seen that the Bills of Quantities data and data on resources are at the very heart of integration. For instance, the estimating, valuations, purchasing, and costing functions all need the cost data on resources. It is therefore necessary to store and maintain all the relevant data on resources.

The following data on each resource needs to be stored:

* resource reference number,
* resource code (may be the same as the reference number),
* description,
* unit of measurement,
* type of resource (labour, plant, materials, other),
* resource group (e.g. 10 mm diameter bars may be grouped under reinforcement),
* type of adjustment for dayworks,
* total quantity budgeted for,
* unit price (estimated),
* unit price (current),
* unit price (dayworks),

* quantity already ordered,
* invoice value of orders,
* quantity already supplied,
* invoice value of supplies,
* quantity fixed in main work,
* quantity used in dayworks,
* daily wage plus guaranteed bonus (labour only),
* wage number (labour only),
* bonus share factor (labour only: e.g. a foreman's bonus share factor is 1.5 where he is paid 1½ times that of general labour for the same hours served),
* Bonus unit rate (labour only).

Some of the data may not be applicable to all resources or in all control systems. Facilities should therefore be made for the System and the user to ignore irrelevant data.

13.5.6 DATA ON CLAIMS

The contribution of claims to valuations is described in Chapter 8. For reasons discussed in that chapter the System should store the following data on each claim:

* claim reference number,
* date of notice of claim,
* description of claim,
* valuation period to which it belongs,

* amounts for labour, plant, materials, sub-contractors and overheads/profits accepted for payment,
* contractor benefiting from the claim (main contractor or identified sub-contractor),
* section to which the claim belongs,
* activity affected by the claim,
* Work Package affected by the claim,
* percentage additions to be effected on labour, plant, materials, sub-contractor and overheads/profit,
* reference to documents relevant to claim, such as correspondence,
* subject to retention/not subject to retention.

For each day that resources are employed on a claim the System should allow the storage and maintenance of the following data on each resource so employed:

* resource reference number,
* quantity used,
* unit price.

13.5.7 DATA ON DAYWORKS

There is a need to store data on daywork sheets. The important data are discussed in Chapter 7. Those to be stored for each day-works sheet are:

* dayworks sheet number,
* dayworks sheet code,
* Instruction ordering dayworks,
* description of task,
* date of commencement,
* date of completion,
* subject to retention/not subject to retention,
* valuation period of issue,
* section of work,
* activity affected,
* Work Package affected,
* Contractor (main contractor or identified sub-contractors),
* details of resources employed.

Data for each resource to be stored are:

* resource reference number,
* quantity of resource,
* unit price.

13.5.8 DAYWORKS SCHEDULE

Details of dayworks schedules are discussed in Chapter 7. Where the Schedule is produced by an institution such as the FCEC the adjustments may change from publication to publication. This raises the specter of having to go through the resources and change dayworks rates whenever changes occur. As part of this research an arrangement to get round this has been designed. The crux of this arrangement involves classifying all resources into Daywork Groups. Members of the same group are subject to the same type of adjustment. Typical groups include:

* contractor's own labour,
* labour-only sub-contractors,
* hired plant,
* contractor's own plant,
* sub-contractor's resources.

The user can devise any other groupings.

Flagging items in the resource database with their dayworks grouping and maintaining only the type of adjustment allows the system to always use the current dayworks rate for each resource without having to edit them individually. As discussed in Chapter 7 adjustments take the form of percentage additions to prime costs and as the groupings are unlikely to exceed 15, the

the task of maintaining current dayworks rates boils down to maintaining about 15 figures.

13.5.9 DATA ON UNFIXED MATERIALS

From the description of the valuation of unfixed materials in Chapter 9, there is a need for the System to store the following data on each item of material:

* resource reference number,
* quantity in stock,
* unit rate (to default to file unit rate),
* percentage to be paid for (to default to 100%),
* valuation period.

13.5.10 DATA ON SECTIONS

The importance of sections for establishing responsibility, and valuation calculations has been discussed in Chapter 5. In that regard the system should store the following data on each section:

* section number,
* description,
* state of completion (outstanding, practical completion or final certificate),
* due date of completion,
* liquidated damages/week.

13.5.11 DATA ON ACTIVITIES

In Chapter 5 the need to relate Bill items to activities is discussed. There is a need to store the following data on each activity:

* activity reference number,
* activity code,
* description,
* unit of measurement,
* unit rate,
* breakdown of unit rate into labour, plant, materials, sub-contractors, overheads/ profit,
* Quantity,
* Bonus target (for bonus calculations),
* standard cost/unit (for cost control),
* standard man hours/unit (for cost control),

13.5.12 DATA ON WORK PACKAGES

The following data on each Work Package should be stored and maintained:

* reference number,
* description,
* budget breakdown into labour, plant, materials, sub-contractors, overheads/ profit.

The importance of the data is discussed in Chapter 5.

13.5.13 DATA ON PURCHASE ORDERS

Important information on purchase orders is described in Chapter 9. Those to be stored and maintained by the System are:

* order registration number,
* supplier number,
* date of order,
* date of due delivery,
* percentage discount,
* details of resources ordered,

Details of resources ordered are:

* resource reference number,
* quantity ordered,
* unit cost.

13.5.14 DATA ON SUPPLIERS

From the discussion in Chapter 9, there is a need to store the following data on each supplier for the purposes of communication:

* reference number,
* name,
* address,
* contact person,
* telephone number,
* resources sold.

13.5.15 DATA ON DELIVERY OF MATERIALS

The need for well understood and documented procedures for receiving materials is described in Chapter 9. The information on deliveries of each material which needs to be stored are:

* resource reference number,
* quantity delivered,
* delivery note number,
* unit cost.

13.5.16 THE NEDO INDICES FOR FLUCTUATION ADJUSTMENTS

The following provisions should be made for both types of indices described in Chapter 11:

(i) The system should allow the storage and maintenance of the indices of each month starting with the Base Month of the first contract.

(ii) At the start of entry of indices for the Base Month the System should assume that each index number is 100 and should remain so unless the user enters a new figure.

(iii) When the index numbers for subsequent months are being entered the system should copy the numbers of the previous month held on file. This way the user needs enter only those indices which have changed since the entry of the previous month's numbers.

(iv) The System should flag each month's indices as either provisional or final.

13.5.17 DATA ON VARIATIONS

The management of variations is discussed in Chapter 7. From that discussion, the following data on each variation which are essential for valuing work affected by variations have to be stored by the System:

* variation order number,
* variation reference code,
* description,
* date of issue,
* instruction number,
* details of items involved (Section 13.5.3).

For each Bill item introduced or affected by a variation, the system should store the following in addition to the data required of each Bill item:

* previous quantity (Ø if rogue item),
* current Bill quantity (Ø if item is omitted),
* previous Bill rate (Ø if rogue item),
* new Bill rate (Ø if item is omitted).

13.6 SPECIFICATION OF PROCEDURES

As discussed in Section 2.3.4 of Chapter 2 the procedure design phase of the system's life-cycle involves determining the computational requirements necessary to link input, output and the data files.

Before procedure design could be undertaken activities, tasks or operations required by the procedures were identified. The specification of procedures describes such activities.

13.6.1 FILE MAINTENANCE

File maintenance refers to the task of keeping data held in files up to date. This involves amending or deleting data already held and adding new data.

As regards file maintenance the general principle to be adhered to is that no data item is absolute. Facilities should therefore be available for every data item to be retrieved, amended or deleted and/or returnedto storage. It should also be possible to add new data to every file. As far as possible the maintenance of each file should be contained in a separate program module. The advantages of this arrangement are discussed in Chapter 2.

Allowances should be made for controlling the users who can edit the various files (Section 13.2).

13.6.2 MEASUREMENT OF PERMANENT WORK

Chapter 6 describes the various ways of determining the quantities of work contained in the Bill of Quantities completed. The following forms of measurement of Bill items from that description should be provided for by the System:

(i) dimensions applicable to individual Bill items;

(ii) dimensions applicable to multiple identified items;

(iii) quantities of individual Bill items;

(iv) quantities applicable to identified Bill items;

(v) value (either as a single lump sum or a number of lump sums to be added up) applicable to individual Bill items;

(vi) value (either as a single lump sum or a number of lump sums to be added up) applicable to identified Bill items;

(vii) percentage complete applicable to individual Bill items;

(viii) percentage complete applicable to identified Bill items;

(ix) percentage complete in a portion or a section, the first and last items of the portion or section being specified;

(x) in proportion to the value of works in progress less preliminaries and P.C. sums as described in Section 10.2.1.1.

Forms of measurements of activities to be allowed for are:

(i) In proportion to the value of works in progress less preliminaries and prime cost sums as described in Section 10.2.1.1.,

(ii) quantities of activities completed,

(iii) value (either a single lump sum or a series of lump sums) to be added up,

(iv) percentage of activity completed.

13.6.3 DATA ENTRY

As far as possible data entry from separate source documents or for a particular transaction should be covered by a separate module. This allows for easy amendments, as discussed in detail in Chapter 2.

13.6.4 ACCESS TO BILL OF QUANTITIES DATA

It has already been discussed in the chapters named below that very often the contract Bill of Quantities has to be rearranged. The situations where this may be done include:

* rearrangements to suit purposes of functions such as valuations, and planning

(Chapters 5 and 6);

* rearrangements due to new items being introduced by variation orders or correction of errors in the original Bills (Chapter 7).

There is therefore a need for the system to provide facilities by which these rearrangements can be carried out quickly and correctly.

For the purpose of carrying out rearrangements and many other tasks easy access to the Bill of Quantities on a page by page basis is usually required. For instance, when a 'rogue' item is introduced by a variation it will be necessary to scan through the items on pages before deciding on where in the Bill to place it. It is therefore essential that the System provides facilities that allow the user to obtain screen displays of any page of the Bill of Quantities.

It will also usually be necessary to obtain data of valuations of Bill items on a page by page basis instead of as individual items. Some of the situations in which this may be necessary include:

* disputes or uncertainty as to how much of items were done when;
* user may want to verify that site measurement data entered into the System are being processed correctly.

It is therefore essential that the System provides a facility which allows the user to scan through valuation data of entire pages of the Bill of Quantities.

13.6.5 BILL AGGREGATION

In Chapter 6 the need to build activities out of the Bill of Quantities was discussed. The System should allow the user to produce a Bill of Activities out of the Contract Bills. The unit rate of each activity should be broken down into its components for labour, plant, materials, sub-contractors, and overheads/ profits.

13.6.6 MANIPULATION OF VALUATION OF MAIN WORK

In Chapter 6 it was discussed that sometimes the basis of valuations may be activities rather than individual Bill items. However, as discussed in Chapter 11, price adjustment by the Work Category method requires that the values of individual items belonging to the same Work Category be added up. Where the Bill items making up an activity belong to the same Work Category there is no problem. However, where this is not the case and valuation is wholly or partly based on activities it implies that the valuation needs breaking down into values of the component Bill items for the purpose of fluctuation adjustments. There is therefore a need for the System to provide a facility that carries this out as discussed in Chapter 6.

It is often necessary to aggregate values of individual Bill items into values of activities completed. The situations in which this may be necessary include:

* progress reporting,
* updating of programs,
* bonus calculations.

There is therefore a need for the System to provide a facility which assist this task.

13.6.7 CONTROL OF MATERIALS

An important point which emerges from the description of materials control procedures in Chapter 9 is the frequent need for information on details of suppliers, orders and deliveries. It is therefore necessary that the System provides the following facilities:

(i) Details of purchase orders should be made available to personnel in charge of taking delivery of materials from suppliers:

(ii) The System should provide information for the following checks to be made.

  * that materials' orders should not exceed total quantities required;
  * that the right materials are delivered;
  * that deliveries do not exceed quantities ordered;
  * that quantities of unfixed materials for which payment is to be requested do not exceed quantities required for the contract;

(iii) The System should produce the quantities of materials which would be used if the usage rates assumed in the estimate were achieved.

(iv) The System should produce monies payable to the various suppliers.

13.6.8 CLAIMS MANAGEMENT

One fact which emerges from the description of claims procedures in Chapter 8 is that there is no unique formula for quantifying claims. Another important fact is the need to keep relevant records on claims. It is in the latter case that computer technology, with its vast storage facilities, may be most beneficial to the management of claims.

The System was specified to allow:

1. the storage and maintenance of details of the usage of resources on claim situations,
2. an interactive interrogation of the System to produce details of resources employed on an identified claim situation on a specified date,
3. an interactive interrogation of the System to produce details of resources used on a specified claim even where the user cannot remember the dates when they were employed,
4. the quantification of claims assuming the Contractor is entitled to reimbursement of

the cost of his resources plus identified percentage additions on labour, plant, materials, sub-contractors and overheads (where the claim is in fact quantified otherwise this method may provide a cross-check or some substantiating evidence),

5. Screen displays of build-ups of claims on a 'cost plus' basis,
6. Where the quantification of a claim is not on a 'cost plus' basis the System should store lump sums for labour, plant, materials, sub-contractors, overheads/profit calculated outside the System.

In effect this means that where the claim is quantifiable on a 'cost plus' basis all the user should be required to do on the claim are:

* specify and store the percentage additions on labour, plant, materials, sub-contractors, overheads/profit.
* store details of resources as and when they are employed on the claims.

Thereafter the System should carry out the quantification whenever it is required. This is intended to allow the user to obtain up to date build-ups on a day-by-day basis even when the circumstances giving rise to the claim are still continuing. This will not only allow monitoring and some control of the situation but will also allow site management to negotiate a settlement with up to date information.

The System is also required to provide a 'catch all' method for the other ways of quantifying claims. This method requires the user to calculate amounts for labour, plant, materials, sub-contractors, overheads/ profits outside the System and to type them in.

13.6.9 EXTERNAL VALUATION

It should be possible to access the data described in Section 13.5.3 and to carry out a valuation in accordance with descriptions in Chapter 5. Where any information is lacking for the carrying out of a complete valuation the user should be prompted to make a decision as to whether to stop the procedure or to proceed using default data. The System should also check that the interim payment is over the stated minimum amount and to alert the user when it is less.

The valuation should be broken down into the component amounts for the various contractors. That is, a statement of retention and of sub-contractors' values should be prepared at valuation.

13.6.10 INTERNAL VALUATION

Allowance should be made for the adjustments to the external valuation to arrive at the internal valuation as discussed in Chapter 5.

13.6.11 MANAGEMENT OF RETENTION FUND

Contractual provisions for retention are described in Chapter 5. The main provisions contained therein which the System should allow for are:

(i) When a section reaches practical completion, half of the retention held on account of that section should be released in the next payment certificate,

(ii) When a final certificate has been issued in respect of a section all retention still held on account of that section should be selected.

(iii) When a practical completion certificate has been issued for the whole contract half the total retention fund should be released, allowance being made for retention released under (i) and (ii) above,

(iv) When a final certificate has been issued for the entire contract all retention still held should be released.

Allowance should be made for corrections where retention has been wrongly released.

13.6.12 MANAGEMENT OF VARIATIONS

The luence of variations on the administration of contracts was described in Chapter 7 and 8. The following facilities derived from these chapters have to be provided for by the System:

(i) It should receive and store the data described under Section 13.5.17,

(ii) The Contract Sum should be automatically updated once the details of a variation have typed into the System,

(iii) Information on activities and Work Packages should be automatically updated for variations,

(iv) It should carry out all calculations for producing reports relating to variations as described under Section 13.3.

13.6.13 CALCULATIONS FOR REPORTS

The System should carry out all the calculations required for preparing the reports under Section 13.3.

13.7 SYSTEMS FLOWCHART

The roles of systems flowcharts and diagrams are described in Chapter 2. The flowchart for PLUS VAL is shown in Figure 2.4.

CHAPTER FOURTEEN .

A DESCRIPTION OF PLUS VAL

Chapter 4 describes the principal features of the Main-computer interface whilst Chapters 5 - 12 describe the operations and procedures involved in the valuations function and how it relates to the other management functions.

This Chapter describes the operation of, and the facilities offered by PLUS VAL. The description is provided under the following headings:

* System's General Description,
* Price Adjustments for Inflation,
* Starting a New Contract on the System,
* Working on an Existing Contract.

The figures show dialogues between PLUS VAL and the user. All underlined text are samples of user input. Generally such input is followed by pressing the RETURN key. Where the user presses only the RETURN, this is indicated by <CR>.

Even with the inadequacy in describing User-Computer interaction in this manner, this Chapter shows very clearly that PLUS VAL:

* carries out all calculations correctly,
* conforms to its specification contained in Chapter 13.

14.1 SYSTEM'S GENERAL DESCRIPTION

PLUS VAL provides facilities which aid the following functions for both building and civil contracts:

* Contract price adjustment for inflation,
* external valuations,
* internal valuations,
* the provision of information for the management of purchasing,
* the provision of information for the control of sub-contractors,
* the provision of yardsticks of performance against which actual performance of labour and plant may be compared for the purpose of taking corrective action.

PLUS VAL is composed of 17000 lines of ANSI FORTRAN 77 code which take up 195 kilobytes of memory. The System is currently held on a PRIME 750 minicomputer of the Loughborough University of Technology.

14.2 PRICE ADJUSTMENTS FOR INFLATION

PLUS VAL aids price adjustments by the formulae methods for both civil engineering and building contracts. The tasks required to be undertaken by the user 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 him access to indices already stored for inspection, amendment or deletion.

Figures 14.1 and 14.2 illustrate samples of data capture and maintenance transactions for civil engineering and building contracts, respectively.

As far as price adjustment is concerned the procedures described above are the only tasks required of the user. All the data retrieval and the calculations necessary for determining the adjustments are undertaken at the time of valuations by the System without the need for interposing any human interface.

14.3 STARTING A NEW CONTRACT ON THE SYSTEM

The System can support 10 contracts. To add a new contract the user has to type in the following types of information:

* the password for the contract,
* general contract information as described in Section 13.2.3.1.

Thereafter the contract is treated as an existing one and the extensive editing facilities which PLUS VAL provides can be used to store additional

```
To work on an existing contract---1
To add a contract-----------------2
To maintain indices (SERIES 2)----3
To maintain indices (BAXTER)------4


Which do you want to do? 4
Date? 6 /84

New indices? -Y/N  Y
Baxter/1 345
Baxter/2 392
Baxter/3 673
Baxter/4 733
Baxter/5 284
Baxter/6 743
Baxter/7 762
Baxter/8 522
Baxter/9 632
Baxter/10 455
Baxter/11 771
Baxter/12 338
Baxter/13 419
Baxter/14 543
Baxter/ <CR>
Final indices ? -Y/N  N

PERIOD: 6 /84
=============

General Labour------------------------1     345.0
Plant & Equipment---------------------2     392.0
Aggregates----------------------------3     673.0
Bricks--------------------------------4     733.0
Cement--------------------------------5     284.0
Cast Iron Products--------------------6     743.0
Roadstone & Bituminous Materials------7     762.0
DERV Fuels----------------------------8     522.0
Gas oil-------------------------------9     632.0
Timber--------------------------------10    455.0
Reinforcement Steel-------------------11    771.0
Light re--rolled bars & sections------12    338.0
Structural Steel----------------------13    419.0
Steelwork Labour----------------------14    543.0
Provisional or final-------------------    PROVISIONAL

<RETURN>.........to amend
FI...............to file
QU..............to Quit
FI
Indices filed
```

Figure 14.1: Data Entry and Maintenance - NEDO Indices For Use in Connection With the Civil Engineering Contract Price Fluctuation Clause.

```
              Date?  5 /84

                     PERIOD: 5 /84
                     =============
General Labour-----------------------1     600.0
Plant & Equipment--------------------2     540.0
Aggregates---------------------------3     759.6
Bricks-------------------------------4     788.6
Cement-------------------------------5     645.6
Cast Iron Products-------------------6     624.3
Roadstone & Bituminous Materials-----7     919.9
DERV Fuels---------------------------8     550.1
Gas oil------------------------------9    1237.9
Timber-------------------------------10    557.0
Reinforcement Steel------------------11    185.7
Light re--rolled bars & sections-----12    436.3
Structural Steel---------------------13    466.2
Steelwork Labour---------------------14    680.0
Provisional or final-----------------     PROVISIONAL

                     <RETURN>.........to amend
                     FI...............to file
                     QU...............to Quit

                    Baxter/1 610
                    Baxter/14 670
                    Baxter/<CR>
                    Final indices ? -Y/N   Y
                      PERIOD: 5 /84
                      =============
General Labour-----------------------1     610.0
Plant & Equipment--------------------2     540.0
Aggregates---------------------------3     759.6
Bricks-------------------------------4     788.6
Cement-------------------------------5     645.6
Cast Iron Products-------------------6     624.3
Roadstone & Bituminous Materials-----7     919.9
DERV Fuels---------------------------8     550.1
Gas oil------------------------------9    1237.9
Timber-------------------------------10    557.0
Reinforcement Steel------------------11    185.7
Light re--rolled bars & sections-----12    436.3
Structural Steel---------------------13    466.2
Steelwork Labour---------------------14    670.0
Provisional or final-----------------     FINAL

                 <RETURN>.........to amend
                 FI...............to file
                 QU...............to Quit
                FI
                 Indices filed
                Date?  END
```

Figure 14.1: Continued.

```
To work on an existing contract---1
To add a contract----------------2
To maintain indices (SERIES 2)----3
To maintain indices (BAXTER)------4

      Which do you want to do?  3
      Month ?6 /84
      New indices ? -Y/N   Y

SERIES TWO OSBORNE INDICES - 6/84
==================================
PROVISIONAL INDICES
           1.... 246.0
           2.... 244.0
           3.... 256.0
           4.... 560.0
           5.... 400.0
           6.... 100.0
           7.... 100.0
           8.... 100.0
           9.... 100.0
          10.... 300.0
          11.... 100.0
          12.... 100.0

       <CR>.....to amend
       FI.......to file
       QU.......to Quit
      <CR>
          Series 2/1 200
          Series 2/2 320
          Series 2/12 400
          Series 2/ <CR>
          Are they final ? -Y/N  N

SERIES TWO OSBORNE INDICES - 6/84
==================================
PROVISIONAL INDICES
           1.... 200.0
           2.... 320.0
           3.... 256.0
           4.... 560.0
           5.... 400.0
           6.... 100.0
           7.... 100.0
           8.... 100.0
           9.... 100.0
          10.... 300.0
          11.... 100.0
          12.... 400.0

         <CR>.....to amend
         FI.......to file
         QU.......to Quit
        FI
        Indices filed
```

Figure 14.2: Data Entry and Maintenance - NEDO Series 2 Indices.

information as they become available. The setting up of a new contract is illustrated in Figure 14.3.

14.4 WORKING ON AN EXISTING CONTRACT

To gain access to the facilities of the System and the information on a contract the user needs the password for the contract. On typing in the right password when prompted by the System to do so, the user can carry out any of the following transactions which are described below:

* Bill Aggregation,
* Measurement,
* Entering Details of Variation Orders,
* Materials Control,
* 'Unscrambling' of Valuations of Activities,
* Building up Valuations of Activities from Valuations of Bill items,
* Control of Retention Funds,
* Editing Data,
* External Valuations,
* Internal Valuations,
* Preparing Reports.

14.4.1 BILL AGGREGATION

This transaction builds up details of activities from those of its component Bill items. Situations in which the user may wish to carry out such a transaction are described in

```
To work on an existing contract---1
To add a contract-----------------2
To maintain indices (SERIES 2)----3
To maintain indices (BAXTER)------4



Which do you want to do?  2
Contract Password?  THESIS
Contract title ?  CONSTRUCTION OF THE M999 MOTORWAY
Contract registration no. ?  DOT/MTU/86/12
Clients ?  THE DEPAT?THE DEPARTMENT OF TRANSPORT
Client"s address ?  12 GREAT GEORGE STREET
                    WESTMINSTER,
                    LONDON 1NV 8UH

Client"s phone no. ?  01-9555 7777
Client"s contact person ?  FELIX SHANNON
Consultants ?  GUGGISBERG AND PARTNERS
Consultant"s address ?  34 COLCHESTER ROAD
                        BURNT OAK,
                        EDGWARE
                        MIDDX HA8 ORA

Consultant"s phone no. ?  959 72728
Consultant"s contact person ?  DERRICK RUSSELL
Main Contractor ?  BONNY AND SONS LTD
Address of Main Contractors ?  86 STROUDGREEN ROAD
                               FINSBURY PARK
                               LONDON HG21 1UY

 1...................ICE
 2...................JCT
 3.........Non-standard
Form of contract ?  1
Commencement date ?  12/1 /84
Completion date ?  12/3 /86
Tender Total/Sum ?  3400427.04
Adjustment Item ?  500000
% Retention ?  3
Limit of Retention ?  800000
Min. value of interim certificates ?  50000
Liquidated damages/week ?  10000
Min amount of insurance ?  30000000
% of Tender Total/Sum as bond ?  10
Base month ?  1 /84


   VI...to view data
   FI........to file
   QU........to Quit
   <CR>.....to amend
 FI
 Contract started
```

Figure 14.3: Starting a New Contract on PLUS VAL

Sections 5.11.2.2.6 and 6.2.2.

The Bill Aggregation facility produces a report which contains the following information:

* build-ups of the various activities,
* a Bill of Activities,
* a breakdown of the budget value of each activity into its components for labour, plant, materials, sub-contractors and overheads/profits

samples of which are shown in Figures 14.4 14.5 and 14.6, respectively.

14.4.2 MEASUREMENT

Measurement here refers to the recording of recurrent data compiled for the valuation period in hand into the System. There are four classes of such data required by the System:

* data on measured work accomplished,
* dayworks records,
* records on claims,
* records on unfixed materials.

14.4.2.1 DATA ON MEASURED WORKS ACCOMPLISHED

This class of data is determined mainly by reference to the Bill of Quantities. The System allows for two approaches to this head of measurement. One approach involves measuring all the work covered by the work item in hand accomplished

BILL AGGREGATION REPORT

2 Drainage

ITEM CODE	ITEM DESCRIPTION	BILL QUANTITY	UNIT	RATE	AMOUNT
3.1996	CONC PIPE N.C.S. 2400mm*1500mm TO DRAWING	61.00	m	18.00	1098.00
3.1997	CONC PIPE N.C.S 2400mm*1500mm TO DRAWING 79/14/40 DEPTH 4-6m	10.00	m	19.00	190.00
3.J9[illegible]9	CONC PIPE BEND,22.5D DEFLECTION EFFECTED OVER 5 PIPE UNITS	1.00	NR	200.00	200.00
3.K6[illegible].1	2400mm*1500mm PIPE CROSSING OVER RAILWAY VIADUCT	1.00	NR	150.00	150.00
3.1699.[illegible]	2400mm*1500mm PIPE CROSSING UNDER GATEWAY TO NEGAS YARD	1.00	NR	100.00	100.00
3.K719	BREAK UP 2400mm*1500mm PIPE & REINSTATE ROADS	21.00	m	15.00	315.00
3.K799	BREAK UP 2400mm*1500mm PIPE & REINSTATEMENT NEGAS YARD	37.00	m	17.00	629.00
3.K859	CONNECTION OF 600mm DIA OVERFLOW PIPE TO 2400mm*1500mm CONC PIPE	1.00	NR	200.00	200.00
3.L[illegible]9	EXCAVATION OF ROCK	2103.75	m3	19.65	41338.62
3.L140	EXCAVATION OF EXISTING 600mm DIA. OVERFLOW PIPE AND SEALING WITH CONC.	30400.00	SUM	1.00	30400.00
3.L150	BACKFILLING WITH CONC GRADE C10/40 AS SPEC CL 4.1	25.00	m3	50.00	1250.00
3.L160	BACKFILLING WITH IMPORTED GRANULAR MATERIAL AS SPEC CL 2.72	1000.00	m3	2.60	2600.00
3.L339	BEDS GRANULAR MATERIAL TYPE A20,PIPE N.C.S 2400mm*1500mm	71.00	m	3.00	213.00
F150	PROVIDE AND PLACE CONCRETE GRADE 30/20	0.00	M3	15.00	0.00
F150.1	PROVIDE AND PLACE CONC. GRADE 22.5/37.5	257.16	M3	20.00	5143.16
2	Drainage	83826.78	sum	1.00	83826.78

Figure 14.4: Sample of the Build-up of an Activity

BILLS OF ACTIVITIES

ACTIVITY	CODE	ACTIVITY DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	99.1	Time-related Preliminaries	104.00	Week	774.04	80500.17
2	99.2	Cost-related Preliminaries	120767.35	sum	1.00	120767.35
3	99.3	General Overheads	230000.00	sum	1.00	230000.00
4	99.4	Demolition and Site Clearance	213175.25	sum	1.00	213175.25
5	99.5	Drainage	83826.78	sum	1.00	83826.78
6	99.6	Services	77111.05	sum	1.00	77111.05
7	99.7	Bulk Earthmoving	2000.00	M3	33.36	66722.11
8	99.8	Sub-base Course	25000.00	M2	3.48	87009.45
9	99.9	Base Course	2000.00	M2	54.59	109189.19
10	99.10	Rigid Pavements	1000.00	M2	185.45	185449.13
11	99.11	Flexible Pavements	500.00	M2	387.96	193981.48
12	99.12	Kerbs	5680.00	M	24.62	139825.17
13	99.13	Paths and Pavement Areas	5120.00	M2	22.82	116850.02
14	99.14	Fencing	10000.00	M	17.35	173477.33
15	99.15	Topsoiling	4850.00	M2	37.35	181155.26
16	99.16	Grassing	4850.00	M2	32.11	155723.73
17	99.17	Attendance on Nom. Subbies	175339.91	sum	1.00	175339.91
18	99.18	All Sub-contracted Works	1010323.66	sum	1.00	1010323.66
		TOTAL				3400427.04

Fiqure14.5: A Sample Bill of Activities.

BREAKDOWN OF VALUES OF ACTIVITIES

NO.	CODE	ACTIVITY DESCRIPTION	LABOUR	PLANT	MATERIALS	SUB-CONTR.	OVERH/PROF
1	99.1	Time-related Preliminaries	16100.03	24150.05	32200.07	0.00	8050.02
2	99.2	Cost-related Preliminaries	24153.47	36230.20	48306.94	0.00	12076.74
3	99.3	General Overheads	46000.00	46000.00	92000.00	0.00	46000.00
4	99.4	Demolition and Site Clearance	42635.05	63952.58	85270.09	0.00	21317.52
5	99.5	Drainage	16765.36	25148.04	33530.71	0.00	8382.68
6	99.6	Services	15422.21	23133.32	30844.42	0.00	7711.10
7	99.7	Bulk Earthmoving	13344.42	20016.63	26688.84	0.00	6672.21
8	99.8	Sub-base Course	17401.89	26102.84	34803.78	0.00	8700.95
9	99.9	Base Course	21837.84	32756.76	43675.67	0.00	10918.92
10	99.10	Rigid Pavements	37089.82	55634.74	74179.64	0.00	18544.91
11	99.11	Flexible Pavements	38796.29	58194.45	77592.58	0.00	19398.14
12	99.12	Kerbs	27965.03	41947.55	55930.06	0.00	13982.52
13	99.13	Paths and Pavement Areas	23370.00	35055.01	46740.00	0.00	11685.00
14	99.14	Fencing	34695.46	52043.20	69390.92	0.00	17347.73
15	99.15	Topsoiling	36231.05	54346.58	72462.11	0.00	18115.53
16	99.16	Grassing	31144.75	46717.12	62289.49	0.00	15572.37
17	99.17	Attendance on Nom. Subbies	35067.98	52601.98	70135.95	0.00	17533.99
18	99.18	All Sub-contracted Works	0.00	0.00	0.00	1008369.62	1953.97
		TOTAL	478020.64	694031.05	956041.28	1008369.62	263964.29

Figure 14.6: Price Breakdowns of Activities.

since the start of the contract. The other involves measuring only the work done since the previous valuation with the System drawing on data of previous valuations to maintain cumulative totals of the work items accomplished. Work items may be individual Bill items or activities.

14.4.2.1.1 MEASUREMENT OF WORK CONTAINED IN BILL ITEMS

The System allows the storage of data covering individual Bill items or multiple items for each of which the same measurements apply.

Measurements may be in the form of:

* dimensions,
* quantities,
* values,
* percentages.

(A) DIMENSIONS

The System prompts the user to type in dimensions of work determined from site measurement or from drawings. Such dimensions may cover work done to date or work done since the last valuation. After the user has entered the dimensions the System carries out all the working up (i.e. squaring, abstracting and billing) calculations and updates the files for measurements accordingly.

Figure 14.7 illustrates the data entry for recording work covered by dimensions.

(B) QUANTITIES

This System prompts the user to type in the quantity of the work item accomplished. Where there are separate quantities for parts of the same work in multiple sections or locations, the user may type in the separate quantities with the System undertaking their addition. Here again data may cover either work done to date or work done since the last valuation.

Quantities may be:

* lengths (e.g., of meters of pipes laid),
* areas (e.g., hectares of site clearance),
* volumes (e.g., M^3 of excavation),
* weight (e.g., tonnes of reinforcement bars),
* time (e.g., weeks of office maintenance),
* sums of money (e.g., insurance premiums).

Figure 14.8 illustrates the data entry for measurements as quantities.

```
            Bill Item Dimensions to date--------1
            Bill Item Dimensions this period----2
            Bill Item Quantitities to date------3
            Bill Item Quantities this period----4
            Bill Item Percentages complete------5
            Bill Item Values to date------------6
            Portions of Bill Sections-----------7
            Activities--------------------------8
            Cost-related Bill Items-------------9
            Cost-related Activities------------10

        Which type to measure?  1
        Items Codes?  2.L110
        Timesing factors?   2/
        Enter length,breadth,height/depth   1.3,3,1
        Signpost   (near borehole
        Timesing factors?  <CR>
        Enter length,breadth,height/depth   1.7,0.8,0.5
        Signpost <CR>
        Timesing factors?   3.143/
        Enter length,breadth,height/depth   2,2,2
        Signpost   (cylindrical col
        Timesing factors? <CR>
        Enter length,breadth,height/depth   1.2,0.3,4.1
        Signpost <CR>
        Timesing factors?   2/3/
        Enter length,breadth,height/depth   1,2,3
        Signpost <CR>
        Timesing factors?   END


     2.L110      EXCAVATION OF ROCK
     ****** WORK DONE TO DATE ******
          2/          1.30
                      3.00
                      1.00
              ------------     (near borehole
                      1.70
                      0.80
                      0.50
              ------------
      3.143/          2.00
                      2.00
                      2.00
              ------------     (cylindrical col
                      1.20
                      0.30
                      4.10
              ------------
        2/3/          1.00
                      2.00
                      3.00
              ------------

        View dimensions.........1
        Add dimensions..........2
        Change dimensions.......3
        Delete dimensions.......4
        File measurement........5
        Stop item measurement...6
       Which to do?  5
        Dimensions filed
```

Figure 14.7: Data Entry - Dimensions of Accomplishments of BOQ Items.

(C) VALUES

The System requires the user to enter the amount earned on account of the work item in hand. Data for an item may be as a single value or several values to be added up by the System. This facility is particularly applicable to:

* work items completed in which case their Bill amounts are earned,
* measurement by reference to stages of construction as described in Section 6.2.3,
* valuation of preliminaries by reference to Preliminaries Budget (Section 10.2.1.1.3).
* valuation of work items by reference to costs incurred on them (Section 10.2.1.1.4)).

The data entry here is similar to that shown in Figure 14.8.

(D) PERCENTAGES

The user is prompted to enter the percentage of the work completed. There are three variants of this facility:

* entry of a percentage to cover an identified Bill item,
* Entry of a percentage to cover each of any number of identified Bill

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

   Which type to measure?  3
   Items Codes?  2.L150
   Quantities?  25.20
   Measurement filed
   Items Codes?  1.A219.3,2.L523,3.L140,4.I127
   Quantities?  59.12
   Measurement filed
   Items Codes?  END

Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

   Which type to measure?  3
   Items Codes?  1.A250.1
   Quantities?  3000
   Measurement filed
   Items Codes?  1.A219.5,2.I346.5,3.L110,4.I115.1
   Quantities?  35
   Measurement filed
   Items Codes?  END
```

Figure 14.8: Data Entry - Quantities of BOQ Items Accomplished.

items which may be taken from any part of the Bill of Quantities,

* entry of a percentage to apply to a continuous portion of the Bill of Quantities, the first and last items of the portion being identified.

Figure 14.9 illustrates the use of this facility.

14.4.2.1.2 ACCESS TO VALUATIONS OF BILL ITEMS

To be able to record the measurements for a Bill item the user has to type in the code of the item. When this is done the System displays the details of the item for inspection and confirmation of the user's intention to enter measurements against it. This facility is illustrated in Figure 14.10.

It has been recognized that some users will sometimes find this facility irritating, or a waste of time. Provision has therefore been made for it to be 'switched off' or 'switched on' as and when the user wishes to do so.

Apart from providing the facility described above for inspecting the valuations of individual items the System also allows the user to inspect valuations of items on pages as illustrated in Figure 14.11.

```
Bill Item Dimensions to date---------1
Bill Item Dimensions this period-----2
Bill Item Quantitities to date-------3
Bill Item Quantities this period-----4
Bill Item Percentages complete-------5
Bill Item Values to date-------------6
Portions of Bill Sections------------7
Activities---------------------------8
Cost-related Bill Items--------------9
Cost-related Activities-------------10

        Which type to measure?  5
        Items Codes?  1.A120
        % of Bill Quantity done to date?  50
        Items Codes?  1.A110,1.A130,1.A140
        % of Bill Quantity done to date?  40
        Measurement filed
        Items Codes?  END

Bill Item Dimensions to date---------1
Bill Item Dimensions this period-----2
Bill Item Quantitities to date-------3
Bill Item Quantities this period-----4
Bill Item Percentages complete-------5
Bill Item Values to date-------------6
Portions of Bill Sections------------7
Activities---------------------------8
Cost-related Bill Items--------------9
Cost-related Activities-------------10

        Which type to measure?  7
        First item? (Bill Section/Page/Item#)?  1 /1  /1
        Last item? (Bill Section/Page/Item#)?  1 /4  /15
        % of Bill Quantity done to date?  20
         Measurements filed
        First item? (Bill Section/Page/Item#)?  END  /
```

Figure 14.9: Data Entry - Percentages of BOQ Items Accomplished.

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

        Which type to measure?  3
        Items Codes?   2.L140.1

              VALUATION NO.  1
              ================
2.L140.1         EXCAVATION OF OLD CELLARS

Bill Reference---------------- 2/  2/  2
Unit--------------------------M3
Bill Quantity----------------     3354.00
Rate:      5.17 (L:      0.00  P:      0.00
M:      0.00    S/C:      4.00  OHP:      1.17)
Cost Center------------------  1
Activity No.-----------------  1
Contractor No.---------------  5
Price Adjustment-------------Price Adjustible
Quantity last Period---------        0.00
Value last Period------------        0.00
Quantity this period---------     1677.00
Value this period------------     8670.09
Quantity to date-------------     1677.00
Value to date----------------     8670.09
         Right item?  Y
         Quantities?  200.50
         Measurement filed
         Items Codes?  NVFY
         Ok,2.L110
         Quantities?  30
         Measurement filed
         Items Codes?  END
```

Figure 14.10: Confirmation of Bill Items Against Which Measurements are Entered.

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

        Which type to measure?  PAGE
        Section/Page ?1 /1
             Section  1 Page  1
             *****************
```

	ITEM CODE	UNIT	RATE	BILL QTY	LAST QTY	QTY NOW	QTY TO DATE
1	1.A110	SUM	1.00	15000.00	0.00	3000.00	3000.00
2	1.A120	SUM	1.00	100000.00	0.00	20000.00	20000.00
3	1.A130	SUM	1.00	20000.00	0.00	4000.00	4000.00
4	1.A140	SUM	1.00	100000.00	0.00	20000.00	20000.00
5	1.A211.1	SUM	1.00	200000.00	0.00	40000.00	40000.00
6	1.A211.2	WK	1000.00	60.00	0.00	12.00	12.00
7	1.A219.1	SUM	1.00	10000.00	0.00	2000.00	2000.00
8	1.A219.2	SUM	1.00	10000.00	0.00	2000.00	2000.00
9	1.A219.3	SUM	1.00	5000.00	0.00	1000.00	1000.00
10	1.A219.4	SUM	1.00	20000.00	0.00	4000.00	4000.00
11	1.A219.5	SUM	1.00	10000.00	0.00	2000.00	2000.00
12	T600	M3	20.00	233.15	0.00	46.63	46.63

***END OF PAGE ***

Figure 14.11: Inspection of Valuations of Pages of the BOQ.

14.4.2.1.3 MEASUREMENT OF WORK CONTAINED IN ACTIVITIES

The user can enter measurements of the accomplishments of activities as:

* total quantity accomplished,
* total value earned on the work completed,
* percentage completed.

Figure 14.12 illustrates the entry of measurements of activities completed.

14.4.2.1.4 COST-RELATED WORK ITEMS

Cost-related preliminaries are explained in Chapter 10. PLUS VAL requires the user to identify cost-related items which it 'flags' for valuation as described in Section 10.2.1.1.1. Once an item is 'flagged' as cost-related the user does not need to repeat the process, for PLUS VAL stores the information for use in all subsequent valuations.

Just as any number of Bill items can be aggregated into activities, cost-related activities can be built from cost-related items of preliminaries in the Bill of Quantities. Such cost-related activities are included in valuations using the approach adopted for cost-related Bill items.

Figure 14.13 illustrates the procedure for identifying cost-related items and activities.

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items--------- ---9
Cost-related Activities------------10

Which type to measure?  8
Activity ?  1

99.1            Time-related Preliminaries

BILL QUANTITY       104.00Week RATE $     774.04/Week  AMOUNT      $  80500.16
-------------                  ----                    ------

STANDARD COST $     705.00/Week  STANDARD MANHOURS     300.00/Week
-------------                    -----------------

                    LABOUR        PLANT    MATERIALS  SUB-CONTR.  OVERH/PROF
                    ------        -----    ---------  ----------  ----------
UNIT RATES:         154.81        232.21     309.62        0.00       77.40

BONUS TARGET          0.00  HR/Week
------------

QUANTITY TO DATE             0.00      AMOUNT TO DATE $       0.00
----------------                       -------------

 Measure as money-----------1
 Measure as quantities------2
 Measure as %---------------3
 File measurement-----------4
 Quit-------------------<CR>

Which to do?  2
Quantities?  4
99.1            Time-related Preliminaries

BILL QUANTITY       104.00Week RATE $     774.04/Week  AMOUNT      $  80500.16
-------------                  ----                    ------

STANDARD COST $     705.00/Week  STANDARD MANHOURS     300.00/Week
-------------                    -----------------

                    LABOUR        PLANT    MATERIALS  SUB-CONTR.  OVERH/PROF
                    ------        -----    ---------  ----------  ----------
UNIT RATES:         154.81        232.21     309.62        0.00       77.40

BONUS TARGET          0.00  HR/Week
------------

QUANTITY TO DATE             4.00      AMOUNT TO DATE $    3096.16
----------------                       -------------

 Measure as money-----------1
 Measure as quantities------2
 Measure as %---------------3
 File measurement-----------4
 Quit-------------------<CR>

Which to do?  4
Measuremen for Activity   1 filed
Activity ?  END
```

igure 14.12: Data Entry - Accomplishments of Activities.

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

Which type to measure?  9
Items Codes?  2.L593,3.I996,4.J192.2
Measurement filed
Items Codes?  END
```

```
Bill Item Dimensions to date--------1
Bill Item Dimensions this period----2
Bill Item Quantitities to date------3
Bill Item Quantities this period----4
Bill Item Percentages complete------5
Bill Item Values to date------------6
Portions of Bill Sections-----------7
Activities--------------------------8
Cost-related Bill Items-------------9
Cost-related Activities------------10

Which type to measure?  10
Activities?  2, 4
Measurements filed
Activities?  END
```

Figure 14.13: The Flagging of Cost-related BOQ Items and Activities.

14.4.2.2 DAYWORKS

PLUS VAL requires the user to:

* maintain a file containing the Contract's Dayworks Schedule,
* record material particulars of dayworks sheets.

14.4.2.2.1 MAINTENANCE OF THE DAYWORKS SCHEDULE

Two types of changes may occur which affect the amount claimable on account of a resource employed on a dayworks basis:

* a change in prime cost,
* a change in the percentage addition to allow for overheads/profits.

Facilities for editing data are discussed in Section 14.4.8.

The classification of resources employed on dayworks is explained in Section 13.2.3.8. Each class has a percentage adjustment which PLUS VAL allows the user to change whenever it is necessary.

Figure 14.14 illustrates the changing of the percentage adjustment for Class 1 (Contractor's own labour).

```
Contract general data--------1
Sub-contractor"s data--------2
Sections data----------------3
Bill items data--------------4
Activities data--------------5
Dayworks Adjustments---------6
Resources data---------------7
Claims data------------------8
Valuation BOQ data-----------9

 Which data to edit?6

GROUP NO.            % ADJUSTMENT
=========            ============
    1                   150.0
    2                    15.0
    3                    15.0
    4                    20.0
   18                     3.0
   20                     0.0

     <CR> to amend
     FI.......to file
     VI.......to view adjustments
     QU.......to Quit
     <CR>
     Enter Group No.,% adjustment    1,155

GROUP NO.            % ADJUSTMENT
=========            ============
    1                   155.0
    2                    15.0
    3                    15.0
    4                    20.0
   18                     3.0
   20                     0.0

     <CR> to amend
     FI.......to file
     VI.......to view adjustments
     QU.......to Quit
     FI
     Adjustments filed
```

Figure 14.14: Changing the Percentage Adjustment For a Dayworks Resource Group.

14.4.2.2 DATA ENTRY FROM DAYWORKS SHEETS

The System prompts the user to type in the material particulars of a dayworks sheet as illustrated in Figure 14.15.

14.4.2.3 CLAIMS

When a claim situation arises the user is required to type in the following particulars, the significance of which are discussed in Chapter 8.

* reference number of the claim,
* brief description,
* date of notice of claim,
* prime costs for labour, plant, materials, sub-contractors, and overheads/profit where they have been determined outside the System,
* section of the work affected,
* contractor or sub-contractor to benefit from the claim,
* activity affected by the claim,
* valuation period to which it belongs,
* amounts accepted for payment in respect of labour, plant, materials, sub-contractors and overheads/profit,
* whether or not the claim is subject to retention,
* references to documents pertaining to the claim,

```
Enter dayworksheet no.   5
Valuation no.?  1
Sheet code    EIN/44
Instruction No.   2
Date of commencement?  12/6 /85
Date of completion?  12/6 /85
Task description  REINSTATEMENT OF BRIDGE AT CH 2345 + 89
Section No.?  1
Activity No.?  1
Work Package?  1
Contractor?  1
Resource ?  23
Enter quantities of resource  8
Rate ?<CR>
Resource ?  32
Enter quantities of resource  8
Rate ?<CR>
Resource ?  9
Enter quantities of resource  8
Rate ?  15.00
 Dayworks rate for resource changed in database
Resource ?  5
Enter quantities of resource  8
Rate ?<CR>
Resource ?  22
Enter quantities of resource  200
Rate ?<CR>
Resource ?  27
Enter quantities of resource  250
Rate ?<CR>
Resource ?  40
Enter quantities of resource  100
Rate ?<CR>
Resource ?  41
Enter quantities of resource  150
Rate ?<CR>
Resource ?  END
```

RESOURCE NO.	DESCRIPTION	UNIT	RATE	QUANTITY
23	JOHN SMITH -LABOURER	HR	4.16	8.00
32	PAINTER	HR	5.00	8.00
9	COMPRESSOR	HR	15.00	8.00
5	LORRY -TIPPER 6 M3	HR	16.37	8.00
22	GRANULAR FILL	M3	8.42	200.00
27	SAND	KG	8.00	250.00
40	UNDERCOAT PAINT	LITR	41.00	100.00
41	GLOSS PAINT	LITR	10.00	150.00

```
<CR>.............to amend
FI...............to file
QU...............to Quit
  Which to do ?  FI
  Dayworks sheet  5 filed
```

Figure 14.15: Data Entry - Dayworks Sheets.

* the quantity and unit rate of each resource employed on the claim situation together with the dates of such employment.

Figure 14.16 illustrates the processing of a claim.

The user can get access to all such data typed in or stored for editing. PLUS VAL also provides access to the build-ups of claims already processed.

14.4.2.4 UNFIXED MATERIALS

This head of measurement is treated under Section 14.4.3.5.

14.4.3 MATERIALS CONTROL

PLUS VAL provides facilities which allow the user to:

* co-ordinate the purchasing and delivery of materials,
* monitor the use of materials.

The System achieves this by storing and maintaining data on suppliers, purchase orders, deliveries and stocks of materials not yet used.

```
Claim no. ?  3
New claim ? -Y/N  Y
Description ?  EXTRA WORK DUE TO UNFORESEEN GROUND CONDITIONS
Date of notice?  5 /4 /85
Prime costs  (lab,plt,mat,other,s/c) ?<CR>
%"s OHP on Prime Costs(lab,plt,mat,other,s/c) ?  5,5,5,0,5
Section ?  1
Contractor ?  1
Activity ?  1
Work package ?  1
Valuation ?  2
Amounts accepted (lab,plt,mat,ohp,S/C) ?<CR>
Subject to retention ? -Y/N  Y
 Type each reference & <CR>
ERT/34
ERT/38
ERT/41
Date ?  3 /6 /85
Resource ?  25
Unit price ?<CR>
Quantities ?  8
Resource ?  29
Unit price ?<CR>
Quantities ?  11
Resource ?  11
Unit price ?<CR>
Quantities ?  8
Resource ?  22
Unit price ?<CR>
Quantities ?  100
Resource ?  END
CLAIM NO.   3  EXTRA WORK DUE TO UNFORESEEN GROUND CONDITIONS
=============

Date:          3/ 6/85
-----


RESOURCE NO.  DESCRIPTION                 UNIT     RATE     QUANTITY
============  ===========                 ====     ====     ========
          25  HAROLD SPELMAN -GANGER      HR       3.12         8.00
          29  BRICKLAYER                  HR       5.00        11.00
          11  JCB 3C EXCAVATOR            HR       8.84         8.00
          22  GRANULAR FILL               M3       8.42       100.00
 <CR>........to amend
 DL..........to delete
 FI..........to file
 QU..........to Quit
FI
 Records filed
```

Figure 14.16: Data Entry - Claims.

14.4.3.1 SUPPLIERS OF MATERIALS

Figure 14.17 shows the type of data on suppliers required by the System. After such data has been entered and stored the user can subsequently get access to it for editing whenever necessary.

14.4.3.2 PURCHASE ORDERS

The data held on each purchase order is shown in Figure 14.18. When details of purchase orders are being entered the System checks that the quantity of any material ordered does not exceed the total quantity required for the Contract without the express approval of the user.

14.4.3.3 DELIVERIES

The System maintains up to date information on deliveries of materials. When the data on a delivery are being entered the System provides the data for cross-checking the details of the delivery. Inconsistencies between the delivery, previous deliveries and purchase orders are brought to the notice of the user for reconciliation.

Figure 14.19 illustrates the data entry for recording a delivery. The System can

```
Supplier No. ?  5
New supplier ?-Y/N   Y
Supplier"s name ?  BLUELAND BRICKS LTD.
Address ?  123 CHARTRERIS CLOSE
           LOUGHBOROUGH,
           LEICESTERSHIRE LE11 ORA

Phone no. ?  0509-4518988
Contact ?  ERIC McWILLIAMS

SUPPLIER NO.   5:        BLUELAND BRICKS LTD.
================


ADDRESS:                 123 CHARTRERIS CLOSE,
=======                  LOUGHBOROUGH,
                         LEICESTERSHIRE LE11 ORA


PHONE NO :               0509-4518988
----------

CONTACT:                 ERIC McWILLIAMS
--------


 <CR>........to amend
 FI..........to file
 QU..........to Quit
FI
 Record filed
Supplier No. ?  END
```

Figure 14.17: Data Entry - Information On Suppliers.

```
Edit Suppliers.............1
Edit orders................2
Edit deliveries............3
Determine fixed material...4
Margins on orders..........5
Margins on deliveries......6
View materials summary.....7
View orders summary........8
View Supplier"s account....9
Wastage report............10

.
Which to do?  2
Order No. ?  2
New order ? -Y/N   Y
Order Registration No. ?   LUT/86/56
Supplier No. ?   3
Date of order ?   21/1 /86
Date of due delivery ?   21/6 /86
Discount ?   2.5
Resource no. ?   44
Quantity ?   500
Unit price ?
Resource no. ?   16
Quantity ?   2500
Unit price ?   350
Resource no. ?   18
Quantity ?   900
Unit price ?
Resource no. ?   END

================================================
ORDER NO.   2
==========
REGISTRATION NO. LUT/86/56
-----------------
DATE OF ORDER: 21/ 1/86
--------------
DELIVERY DATE: 21/ 6/86
--------------
SUPPLIER NO.   3:  JEWSON BUILDING MATERIALS LTD.
----------------
DISCOUNT RATE:   2.5 %
================================================
NO.    DESCRIPTION                QUANTITY  UNIT  UNIT PRICE
===    ===========                ========  ====  ==========
 44    40mm TARMACADAM              500.00  KG          0.90
 16    10MM M.S. REBAR             2500.00  TNNE      350.00
 18    10MM H.T. REBAR              900.00  TNNE      280.66

          <CR>.........to Amend order
          VI............to View order
          FI............to File order
          QU..................to Quit
          FI
          Record filed
          Order No. ?  END
```

Figure 14.18: Data Entry - Information on Purchase Orders.

```
        Edit Suppliers.............1
        Edit orders................2
        Edit deliveries............3
        Determine fixed material...4
        Margins on orders..........5
        Margins on deliveries......6
        View materials summary.....7
        View orders summary........8
        View Supplier"s account....9
        Wastage report............10

  Which to do?  3
  Order No. ?   2
  Date ?   22/6 /86
  Resource No. ?   44

  Quantity ?  300
  Unit price ?<CR>
  Delivery note no. ?   ERT/77


  ==============================================================


  DATE:                       22/ 6/86
  =====
  PURCHASE ORDER NO.   2: LUT/86/56
  =======================
  RESOURCE NO.    44:40mm TARMACADAM
  -------------------
  SUPPLIER:                   JEWSON BUILDING MATERIALS LTD.
  ---------
  ORDERED QUANTITY:               500.00  KG
  -----------------
  DELIVERIES TO DATE:               0.00  KG
  -------------------
  THIS DELIVERY:                  300.00  KG     @  $       0.90 /KG
  --------------
  DELIVERY NOTE:              ERT/77
  --------------

  ==============================================================

   <CR>.......to Amend
   DL.........to delete
   FI.........to file
   QU.........to Quit
  FI
   Record filed
```

Figure 14.19: Data Entry - Deliveries of Materials.

subsequently make such information available to the user whenever he wants it. The user may specify dates for which he wants information on deliveries of specified materials or he may indicate that he has no recollection of the exact date in which case the System retrieves all dates in its files for the user's confirmation.

14.4.3.4 BUYING MARGINS

The significance of any differences between the prices assumed at tender for materials and their actual purchase prices is discussed in Section 9.2.4. The System can produce the Buying Margins Report illustrated in Figure 9.1. Figure 14.20 shows a sample of a Buying Margins Report produced by PLUS VAL.

14.4.3.5 THE MEASUREMENT OF UNFIXED MATERIALS

PLUS VAL has a facility for aiding the determination of the amount to be included in external valuations for unfixed materials. To allow the inclusion of a round lump sum for miscellaneous items as described in Section 9.4.2, an appropriately described lump sum item with £1.00 as the unit rate

MARGINS ON ORDERS -SELECTED MATERIALS

RESOURCE NO.	QUANTITY	UNIT	ESTIMATE RATE	ESTIMATE SUM	ORDERED RATE	ORDERED SUM	GAIN	LOSS
15	6MM M.S. REBAR							
	550.00	TNNE	311.85	171517.49	312.23	171726.49		209.00
16	10MM M.S. REBAR							
	375.00	TNNE	311.85	116943.74	278.11	104291.24	12652.50	
18	10MM H.T. REBAR							
	580.00	TNNE	250.00	145000.00	251.77	146026.59		1026.59
19	20MM H.T. REBAR							
	700.00	TNNE	250.00	175000.00	248.00	173600.00	1400.00	
22	GRANULAR FILL							
	2500.00	M3	8.42	21049.86	8.11	20275.00	774.86	
33	FACING BRICKS							
	250.00	THOU	74.00	18500.00	72.22	18055.00	445.00	
40	UNDERCOAT PAINT							
	1780.00	LITR	10.00	17800.00	8.90	15842.00	1958.00	
41	GLOSS PAINT							
	2150.00	LITR	10.00	21500.00	9.10	19565.00	1935.00	
58	PORTLAND CEMENT TO BS12							
	1200.00	TNNE	48.76	58512.00	48.07	57684.00	828.00	
							19993.36	1235.59
							1235.59	
	Overall Margin						18757.77	

Figure 14.20: A Sample Buying Margins Report

should be included in the resources database.

The data entry for recording stocks of unfixed materials is shown in Figure 14.21. The user may store such data away, retrieve it for inspection at a later time and add more materials if necessary.

14.4.3.6 MATERIALS USAGE REPORTS

The System allows the user to determine losses and wastages of materials from the following information and data contained in its files:

* estimating data (build-ups of items),
* investories of unfixed materials,
* information on deliveries,
* valuations of work items.

For any material,

Wastage/Saving = quantity delivered - quantity fixed according external valuation and work item build-ups
- stocks (i.e. quantity unfixed)

It follows therefore that the data in the right hand side of the equation must be available to if the wastages/savings are to be determined. Whenever the user attempts to use this facility without prior storage of the necessary data the System issues messages

MEASUREMENT OF UNFIXED MATERIALS

VI..............View Measurents
AD.......Add/Amend Measurements
DL..........Delete Measurements
<CR>......................Quit

Which to do ? AD
Resource ? 15
Enter quantities of resource 200
Unit price ? <CR>
<CR> if 100%
Percentage to be paid for ? <CR>
Section ? <CR>
Activity ? <CR>
Work Package ? <CR>
Resource ? 16
Enter quantities of resource 100
Unit price ? <CR>
<CR> if 100%
Percentage to be paid for ? 70
Section ? <CR>
Activity ? <CR>
Work Package ? <CR>
Resource ? 17
Enter quantities of resource 110
Unit price ? <CR>
<CR> if 100%
Percentage to be paid for ? 80
Section ? <CR>
Activity ? <CR>
Work Package ? <CR>
Resource ? 40
Enter quantities of resource 180
Unit price ? <CR>
<CR> if 100%
Percentage to be paid for ? 50
Section ? <CR>
Activity ? <CR>
Work Package ? <CR>
Resource ? END

VALUATION NO. 1 -UNFIXED MATERIALS

MAT. NO.	DESCRIPTION	QUANTITY	UNIT	RATE	PROP	CTOR
15	6MM M.S. REBAR	200.00	TNNE	47.00	100	1
16	10MM M.S. REBAR	100.00	TNNE	280.00	70	1
17	10MM M.S. REBAR	110.00	TNNE	250.00	80	1
40	UNDERCOAT PAINT	180.00	LITR	10.00	50	1

End of Unfixed Materials

<CR>............to amend
FI..............to file
QU..............to Quit
FI
Measurement filed

indicating the data missing.

A sample Materials Usage Report is shown in Figure 14.22.

14.4.3.7 MATERIALS EXTRACTION

The Materials Controller may wish to answer the question: if materials had been used at the rates assumed at tender how much of each material should have been used to data bearing in mind the work completed? Uses of such information include:

* it provides the second term of the right hand side of the equation for determing wastages/savings of materials;
* it can be used to update estimating data on allowances for wastages;
* cross-checking of applications for payments for unfixed materials;

PLUS VAL can carry out the 'extraction' of materials required by the question but to be able to use this facility the System requires the user to have:

* input the build-up data for the relevant Bill items,
* measured all the relevant work accomplished to date.

MATERIALS USAGE REPORT

CONTRACT CONSTRUCTION OF THE M999 MOTORWAY

DATE up to 13/ 3/84

MATERIAL	DESCRIPTION	FIXED	BOUGHT	STOCK	USED	GAIN	LOSS	%
15	6MM M.S. REBAR	112.76	550.00	421.00	129.00		-16.24	-12.59
16	10MM M.S. REBAR	169.14	375.00	195.00	180.00		-10.86	-6.03
17	12MM M. S. REBAR	124.04	800.00	680.00	120.00	4.04		3.36
18	10MM H.T. REBAR	191.69	580.00	400.00	180.00	11.69		6.50
19	20MM H.T. REBAR	597.63	700.00	75.00	625.00		-27.37	-4.38
22	GRANULAR FILL	1953.00	2500.00	533.00	1967.00		-14.00	-0.71
27	SAND	873.00	1250.00	344.00	906.00		-33.00	-3.64
33	FACING BRICKS	153.00	250.00	120.00	130.00	23.00		17.69
40	UNDERCOAT PAINT	1197.00	1780.00	600.00	1180.00	17.00		1.44
41	GLOSS PAINT	1224.00	2150.00	940.00	1210.00	14.00		1.16
56	COATED ROADSTONE	525.00	855.00	275.00	580.00		55.00	-9.48
59	PORTLAND CEMENT TO BS12	942.50	1200.00	250.00	950.00		-7.50	0.79

Figure 14.22: A Sample Materials Usage Report.

Upon selecting the right option in the right menu, PLUS VAL carries out the 'extraction' without any further input from the user. For a sizeable Bill of Quantities this transaction can take more than 5 minutes and the user can therefore go away and do other tasks during that time.

Figure 14.23 illustrates the operation of the Materials Extraction facility.

14.4.4 VARIATION ORDERS

The System allows the Contract Bill of Quantities to be amended to take into account variation orders. Variation orders may affect the Bill of Quantities in three ways:

* items in the original Bill may be deleted;
* some details of an existing bill item may be amended;
* new items (rogue items) may be introduced.

The System allows the user to delete or modify items existing in the original Bill of Quantities. It allows the user to insert a rogue item anywhere in the original Bill of Quantities and to renumber the items accordingly.

For each variation order the System prompts the user to input the following information:

* variation order number,

```
Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13


    Which to do?  6
    Materials being extracted
    Materials extraction completed


Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13


    Which to do?  END
```

Figure 14.23: The Operation of the Materials Extraction Facility.

* variation reference code,
* brief description,
* date of issue,
* instruction number.

A run which illustrates how the information is input and stored is shown in Figure 14.24.

14.4.4.1 DELETING A BILL ITEM

To be able to delete a Bill item the user must know its code. Figure 14.25 illustrates the deletion of the item with code F150.

14.4.4.2 MODIFYING A BILL ITEM

The run shown in Figure 14.26 shows a transaction which is made necessary by a variation which changes the Bill quantity of the item with code 2.L160.1 from 150M3 ti 175M3.

14.4.4.3 ADDING A ROGUE ITEM

The run shown in Figure 14.27 illustrates a transaction to add a new item with code F150.1. The user for his own reasons has decided to put it as item 12 on page 2 of Bill No. 1.

```
Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13


Which to do?  4
Variation Order #?  1
New V.O.?  Y
Instruction No.?  1
Reference Code?  ERT/23
Description?  REPLACE DRAWING NO. LUT/12 WITH
              DRAWING NO. LUT/27
Date of issue  21/1 /86



V.O. NO.   1      REPLACE DRAWING NO. LUT/12 WITH
===========       DRAWING NO. LUT/27

REFERENCE CODE:   ERT/23
===============

INSTRUCTION NO.    1
===============

DATE OF ISSUE:    21/1 /86
==============


 DS.........change description
 RC.........change Reference Code
 IN.........change Instruction No.
 DA.........change date of issue
 FI.........file
 IT.........VO items
FI
 Record filed
```

Figure 14.24: Data Entry - Variation Orders.

```
Variation Order #?  1

V.O. NO.   1      REPLACE DRAWING NO. LUT/12 WITH
............      DRAWING NO. LUT/27

REFERENCE CODE:  ERT/23
..............

INSTRUCTION NO.   1
..............

DATE OF ISSUE:   21/1 /86
..............

DS.........change description
RC.........change Reference Code
IN.........change Instruction No.
DA.........change date of issue
FI.........File
IT.........VO items
IT
Item Code?  F150
PROVIDE AND PLACE CONCRETE GRADE 30/20

Bill Reference----------------  1/  2/ 11
Unit--------------------------M3
Bill Quantity----------------        195.00
Rate:     15.00 (L:      5.00    P:      5.00
M:      5.00    S/C:      0.00  OHP:       0.00)
Work Package-----------------   2
Activity No.-----------------   2
Contractor No.---------------   1
Price Adjustment-------------Price Adjustable

V.O. Page No.?  1
Page currently empty
V.O page item no. ?  1

AQ..........Amend Quantity
AR..........Amend rate
AD..........Add dimensions
CD..........Amend dimensions
DD..........Delete dimensions
VI..........View dimensions
QU..........Quit
<CR>........Continue

 AQ
 Additional Quantities ?  195
Bill quantity is          195.00
Input quantity is         195.00

AD...........Add to Bill Quantity
SU...........Subtract from Bill Quantity
RP...........Replace Bill Quantity
QU...........Quit
<CR>.........Amend
SU
          V.O.#   1
          .........
PROVIDE AND PLACE CONCRETE GRADE 30/20

Bill Reference----------------1/  2/ 11
V. O. Page -------------------  1
V. O. Item No.----------------  1
Item Unit---------------------M3
New Rate----------------------        15.00
Old Rate----------------------        15.00
New Quantity------------------         0.00
Old Quantity------------------       195.00


<CR> ....to amend
VI.......To view Dimensions
DL.......to delete Item from V.O.
FI.......To file Item as varied
BL.........to edit item buildup
QU.......to QUIT
FI
Variation filed
ItemCode?  2.L160.1
```

Figure 14.25: Deleting Bill Item.

```
Item Code?  2.L160.1

BACKFILLING PIPE TRENCH WITH IMPORTED
MATERIAL AS SPEC CL 2.72

Bill Reference---------------- 2/  2/  5
Unit--------------------------M3
Bill Quantity----------------      150.00
Rate:       2.49 (L:      0.75  P:      0.75
M:      0.62    S/C:      0.00  OHP:      0.37)
Work Package------------------   1
Activity No.------------------   1
Contractor No.----------------   1
Price Adjustment--------------Price Adjustable

AQ..........Amend Quantity
AR..........Amend rate
AD..........Add dimensions
CD..........Amend dimensions
DD..........Delete dimensions
VI..........View dimensions
QU..........Quit
<CR>........Continue

AQ
Additional Quantities ?  175
Bill quantity is         150.00
Input quantity is        175.00

AD...........Add to Bill Quantity
SU...........Subtract from Bill Quantity
RP...........Replace Bill Quantity
QU...........Quit
<CR>.........Amend

RP
          V.O.#   1
          =========
BACKFILLING PIPE TRENCH WITH IMPORTED
MATERIAL AS SPEC CL2.72
Bill Reference---------------- 2/  2/  5
V. O. Page --------------------  3
V. O. Item No.-----------------  1
Item Unit---------------------M3
New Rate----------------------        2.49
Old Rate----------------------        2.49
New Quantity------------------      175.00
Old Quantity------------------      150.00


<CR> to amend
VI.......To view Dimensions
DL.......To delete Item from V.O.
FI.......To file Item as varied
BL.........to edit item buildup
QU.......to QUIT
FI
Variation filed
Item Code?  F150.1
```

Figure 14.26: Amending a Bill Item

```
Item Code?  F150.1
Not in BOQ. New item? -Y/N   Y
Bill Section?  1
Bill Page?  2
There currently  11 items in this page
Item no. ?  12
V.O. Page?  1
There currently   1 items in this page
Item no. ?  2
Linear...............1
Super................2
Cubic................3
Non-dimensional...<CR>

Dimensional type ?  3
Prelims.....................................1
Provisional Sum.............................2
PC (Nom. Supplier)..........................3
PC (Nom. S/C)...............................4
Statutory Undertaker/Authority..............5
% Profit on PC Item.........................6
% (Attendance on Nom. S/C)..................7
% (Attendance on Nom. Supplier).............8
% Profit on Stat. Undertaker................9
% (Attendance on Stat Undertaker)..........10
Other....................................<CR>

Item type ?<CR>
Description ?   PROVIDE AND PLACE CONC. GRADE 22.5/37.5
Unit ?   M3
AQ..........Amend Quantity
AR..........Amend rate
AD..........Add dimensions
CD..........Amend dimensions
DD..........Delete dimensions
VI..........View dimensions
QU..........Quit
<CR>........Continue

AD
Timesing factors?   2/
Enter length,breadth,height/depth   2,2,2
Signpost <CR>
Timesing factors?   2/5/
Enter length,breadth,height/depth   1.5,1.8,2.1
Signpost <CR>
Timesing factors? <CR>
Enter length,breadth,height/depth   2,5,2,1.9
Signpost <CR>
Timesing factors?   3.143/0.25/
Enter length,breadth,height/depth   3,3,3
Signpost <CR>
Timesing factors?   9/
Enter length,breadth,height/depth   1,3,5
Signpost <CR>
Timesing factors?   0.5/
Enter length,breadth,height/depth   4.5,1.3,2.9
Signpost <CR>
Timesing factors?   END
Bill Quantity is   257.16
Rate ?  20
Rate Breakdown(lab,plt,mat,s/c,ohp) ?   5,5,5,0,5
Resource no ?  END
Subject to price-adjustment ? -Y/N   Y
Activity No.:-?  2
Work Package ?  2

 PROVIDE AND PLACE CONC. GRADE 22.5/37.5


Bill Reference----------------1/  2/ 12
Unit--------------------------M3
Bill Quantity-----------------     257.16
Rate:    20.00 (L:      5.00   P:      5.00
M:    5.00    S/C:      0.00  OHP:      5.00)
Work Package----------------- 2
Activity No.----------------- 2
Contractor No.--------------- 1
Price Adjustment--------------Price Adjustable


<CR> ..to amend
QU.....to Quit
FI.....to File
FI
Variation filed
ItemCode?  END
```

Figure 14.27: Adding a 'Rogue' Item.

14.4.5 'UNSCRAMBLING' OF VALUATIONS OF ACTIVITIES

This facility allows the breakdown of any valuations of activities into valuations of their constituent Bill items on an averaging basis. The operation of the facility is shown in Figure 14.28.

14.4.6 AGGREGATION OF VALUATIONS

This facility allows the user to convert valuations of individual Bill items into valuations of the activities of which they are part. Situations in which the user would wish to do this include:

* determining the stage of completion of activities for progress reporting,
* carrying out building contract fluctuation adjustments by the formula method using the Work Group alternative,
* revising programs.

Obviously the user must not attempt to use the facility unless he has carried out valuations of Bill items. Most of the tasks involved here entail 'number crunching' and for a large Bill of Quantities they may take over 5 minutes in which case the user may go away and do other things in that time.

Figure 14.29 illustrates the operation of this facility.

```
Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13

Which to do? 8
Valuation bill being prepared
Valuation bill has been prepared
<CR> to continue
<CR>

Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13

Which to do? END
```

Figure 14.28: The Operation of the Facility For Breaking Down Valuations of Activities into Valuations of BOQ Items.

```
Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13



Which to do?  7
Aggregation of valuation bill in progress
Aggregation of valuation bill completed
<CR> to continue
<CR>



Bill Aggregation-------------1
Measurement------------------2
Registering a Claim----------3
Variations Orders------------4
Materials control------------5
Materials extraction---------6
Valuation Aggregation--------7
Valuation BOQ----------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13

    Which to do?  END
```

Figure 14.29: The Operation of the Facility For Aggregating Valuations of BOQ Items into Valuations of Activities.

14.4.7 CONTROL OF RETENTION FUNDS

PLUS VAL automatically determines retention which it holds back unless the user expressly specifies that any part of it should be released. The System allows the user to make any of the following types of retention releases:

* release of one half of the retention held on any section,
* release of one half of the retention held on the entire contract,
* release of all retention on any section,
* release of all retention on the entire contract.

Figure 14.30 illustrates the operation of this facility. After such transactions are carried out all subsequent valuations reflect the retention released without any need for the user to repeat it.

The System allows the user to annul any release of retention found to be invalid. Figure 14.31 illustrates the operation of this facility.

14.4.8 EDITING OF DATA

PLUS VAL provides facilities which maintain all the data necessary for valuations and materials control. Generally, at data

```
Bill Aggregation-------------1
Measurement-----------------2
Registering a Claim---------3
Variations Orders-----------4
Materials control-----------5
Materials extraction--------6
Valuation Aggregation-------7
Valuation BCQ---------------8
To release retention funds---9
Editing data----------------10
External Valuation----------11
Internal Valuation----------12
Reports---------------------13

Which to do?  9

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option   HTS
Section ?    2, 5, 7, 8

Half retention released

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option   FTS
Section ?    3, 4

Full retention released

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option   END
```

14.30: The Operation of the Facilities For Releasing Retention Funds.

```
Bill Aggregation---------------1
Measurement--------------------2
Registering a Claim-----------3
Variations Orders-------------4
Materials control-------------5
Materials extraction----------6
Valuation Aggregation---------7
Valuation BOQ-----------------8
To release retention funds- --9
Editing data------------------10
External Valuation-----------11
Internal Valuation-----------12
Reports----------------------13

Which to do? 9

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option FTS
Section ?  4, 6

Full retention released

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option RJS
Section ?  6

 Rejuvevation done

HTS-- half retention for sections
HTC-- half retention for contract
FTS-- full retention for sections
FTC-- full retention for contract
RJS-- Rejuvenate sections
RJC-- Rejuvenate contract

Enter an option END
```

Figure 14.31: The Operation of the Facility For Reversing Wrong Release of Retention Funds.

entry the System requires the user to confirm the correctness of the data before it is filed away. Whenever the user discovers errors he is allowed to correct them. Apart from that opportunity to edit data the System also allows the user to access any stored data for inspection, or editing.

14.4.9 EXTERNAL VALUATION

The System can produce external valuations after the user has provided it with all the relevant data. Data required by the System include:

* site measurements of work completed,
* inventories of unfixed materials intended for the Contract,
* material particulars of claims accepted for payment,
* dayworks sheets,
* NEDO indices.

Whenever this facility is used the following reports are produced:

* fluctuation calculations,
* external valuation for transmission to the Architect/Quantity Surveyors/Engineer,
* Statement of Retention and of Nominated Sub-contractors' Values.

Samples of these reports are illustrated in Appendices 11, 12 and 13, respectively.

14.4.10 INTERNAL VALUATION

It is discussed in Chapter 5 that to produce the internal valuation the external valuation is usually adjusted. The extensive editing facilities of PLUS VAL allow the user to carry out these adjustments prior to carrying out internal valuations.

A Resource Analysis Report which shows a breakdown of the internal valuation into earnings on Work Packages can be produced by the System. A sample Resource Analysis Report is shown in Appendix 14.

14.4.11 PREPARATION OF REPORTS

PLUS VAL produces some reports as by-products of certain of its facilities. For example, fluctuation calculations and Statements of Retention and of Nominated Sub-contractors' values are produced whenever an external valuation is carried out. Various reports produced in this way are specified in earlier sections of this Chapter.

PLUS VAL can produce other reports through its report generating facility.

Reports produced by this facility include:

* Updated Contract Bill of Quantities,
* Valuations of Bill Items,
* Listing of Contract Resources,
* Dayworks Sheets,
* Dayworks Account Summary,
* Valuations of Unfixed Materials,
* Dimension Sheets,
* Bill of Variations,
* Claims Daily Accounts,
* Summary of Claims,
* Sub-contractors' Letting Margins Report.

Samples of these reports are shown in Appendices 15 - 25.

CHAPTER FIFTEEN

THE TESTING AND ASSESSMENT OF THE SYSTEM

It is discussed in Chapter 4 that the main aims of testing are to ensure that:

* the System conforms to its specification
* the System is both suitable for its purpose and is acceptable to its intended users.

Chapter 14 contains samples of tests which clearly demonstrate that conformity to its specification and suitability for its purpose have been achieved. This Chapter discusses the findings of assessments of the System as to its suitability for its purpose and acceptability to its intended users.

The following types of assessments were carried out:

* a comparison of the System with its specification,
* an examination of feedback from potential users to whom demonstrations of the System were given,
* a comparison of the System with similar systems commercially available.

15.1 COMPARISON OF THE SYSTEM WITH IT'S SPECIFICATION

An examination of the sample run of the System as described in Chapter 14 shows that it conforms closely to its specification which is described in Chapter 13.

15.2 DEMONSTRATIONS OF THE SYSTEM

In order to stimulate comments from the industry 21 demonstrations of the System were given to various types of its intended users. The types of groups contacted were:

* two evening seminars of the CIOB each of which entailed giving demonstrations to three groups of 8 people mostly from contracting organisations,
* 5 groups from civil engineering, building and petro-chemical contractors,
* 3 software houses,
* 7 individual quantity surveyors, builders and engineers.

These demonstrations were additional to those given to colleagues and lecturers within the Civil Engineering Departmentof the Loughborough University of Technology.

The demonstrations provoked numerous comments, criticisms and suggestions. Where the suggestions were perceived to be useful the System was enhanced as described in Section 2.2.3.

15.2.1 FEEDBACK FROM DEMONSTRATIONS

The strong points of PLUS VAL as indicated by feedback from the demonstrations include the following:

(i) It is completely free of computer science jargon.

(ii) The dialogue employed by the System is one that its intended users can immediately understand without the need for extensive user support.

(iii) It covers all the methods and procedures used by those contacted.

(iv) The reports produced by the System and its screen displays are very readily identifiable with the corresponding documents produced manually.

(v) The software houses were particularly impressed with the structure of the package.

(vi) The structure was perceived to permit easy maintenance and implementation on a variety of hardware.

The System allows for various types of flexibility:

* The user can carryout the transactions involved in any order that he desires.
* The user can spread the transactions over any period of time. For instance he may accumulate all data and carry out a

valuation in a day or he may feed the data into the System on a day-to-day basis with only a little work to do on the valuation day.

* The System allows the User to work at any level of detail of his choice. For instance, he can price dayworks by:
  - calculating lump sums of money for labour, plant, and materials outside the System and then feeding them into it, or
  - entering quantities and other details of the individual items of resources employed on the daywork into the System which then carries out all the necessary calculations.

(vii) The System allows the user to get quick access to information and data on the Contract. Anyone who has ever tried to find, for example, the quantity of an item completed during a certain valuation period will readily appreciate the significance of the facility. The significance is that by making data and information a few strokes at the keyboard away from the user the System considerably reduces time wasted rummaging through files.

(viii) The System achieves a high degree of integration of data. Examples of such integration are:

* PLUS VAL accesses files of the appropriate NEDO indices and effects the necessary fluctuation of price adjustments automatically. This facility is a vast improvement over maintaining separate packages for price adjustment and valuations and transferring data between them manually.

* PLUS VAL can use the Bill of Quantities and Bill item build-ups left over from the estimating function.

* PLUS VAL allows the valuations and the purchasing management functions to share common data and information on purchases of materials. Such data and information are also usable by the planning function.

* The System maintains one file on each of the following which are used or usable by the estimating, valuations, planning, cost control, accounting, cashflow functions:

  . BOQ,

  . activities,

  . valuations,

  . costs data for resources.

* The valuations part of PLUS VAL builds up activities which are needed by the planning

and cashflow functions.

* The System provides the stages of completion of the various activities which are required by the planning and cashflow functions to update programs and cashflow forecasts.
* The valuations part of PLUS VAL can use data left by the estimating function to produce earnings on Work Packages against which actual costs collected along the same Work Packages may be compared by the cost control function.
* The materials control part of PLUS VAL provides all the data required by the accounts division to settle the payments of suppliers of materials.
* PLUS VAL determines materials' wastages by drawing on data generated by the valuations and estimating functions.

(ix) The level of integration achieved or made possible will provide the following advantages:

* The System reduces costs of data capture, Examples include:
  . Bill of Quantities left by estimators can be transferred to the valuations function electronically,
  . Valuations provides yardsticks for cost control which can be transferred electronically to a suitable cost control package.
* The use of common data files by the various functions ensures that they use the same data values.

and cashflow functions.

* The System provides the stages of completion of the various activities which are required by the planning and cashflow functions to up-date programs and cashflow forecasts.

* The valuations part of PLUS VAL can use data left by the estimating function to produce earnings on Work Packages against which actual costs collected along the same Work Packages may be compared by the cost control function.

* The materials control part of PLUS VAL provides all the data required by the accounts division to settle the payments of suppliers of materials.

* PLUS VAL determines materials' wastages by drawing on data generated by the valuations and estimating functions.

(ix) The level of integration achieved or made possible will provide the following advantages:

* The system reduces costs of data capture. Examples include:
  . Bill of Quantities left by estimators can be transferred to the valuations function electronically,
  . Valuations provides yardsticks for cost control which can be transferred electronically to a suitable cost control package.
* The use of common data files by the various functions ensures that they use the same data values.

* The use of common data files saves storage by avoiding duplication.
* The System allows the user to answer questions which require data from more than one function. For example, the user determines wastages on materials by drawing on data from estimating, valuations and purchasing management

(x) The System alerts the user when the implications of his transactions conflict with the Conditions of Contract. For example, when the user enters a quantity of a work item completed which is in excess of the Bill quantity the System alerts the user in the case of building contracts because building contracts do not allow that situation.

(xi) After the various parties involved in valuations are convinced of the satisfactory performance of the System the need to cross-check calculations will be eliminated. This will result in savings of time to senior site management and the Employer's supervision team. The ultimate result would be a reduction of the time lag between measurement and certification.

The aspects of PLUS VAL perceived as its weakness include the following:

(i) No contractor has yet used it in a real project situation. This view accords with the conservative attitude to, and the suspicion of innovation discussed in Chapter 3. The solution to this problem is to convince established and respected contractors to use the System for, as discussed in Chapter 3, the acceptability of innovation often depends on the public standing of the parties identified with it.

(ii) The System is too comprehensive for any one organisation. This means that only a small fraction of the facilities available will actually be required by the organisation. This feature is the result of a deliberate systems design decision. A way out of this has been provided by the use of a structured design. This will allow implementers of the System to go through the System and select only those features desired by the particular organisation.

(iii) Reports on computer printout are inconvenient to handle and file. This reaction was perceived as a manifestation of professional anxiety which can be combatted by appropriate techniques discussed in Chapter 4. In any case computer printout can be photo-reduced to the desired size of paper. A better way round this problem is to edit documents using wordprocessing software.

(iv) There are too many menus. The menus may be desirable for new users but with experienced users they will be a source of irritation.

(v) The need to record site measurements on paper and to subsequently type them into the System for processing would not save professional time. At best only the time for carrying out the calculations might be reduced and since most of such calculations are usually delegated to clerks the System may result in only a reduction of clerical effort. Most people expressed the view that the level of delegation was less in their organisations.

An examination of this criticism shows that it is not a serious detraction from the benefits of the System. Cooke and Jepson (155) write that the first reaction of a manager when he receives an adverse report is to review the source data and the calculations involved. Where a system is proved no such time need be wasted.

From the author's experience with British contractors overseas, discussions with U.K. postgraduate students with the appropriate industrial experience, and the contrary views raised by other participants, the level of delegation is, in the majority of cases, much less than suggested.

Even if the criticism is fair the System can still avoid clerical errors which can potentially lead to wrong decisions and undesirable financial consequences.

(vi) The possibility of entering site measurement data directly into a hand-held computer instead of recording them first on paper was considered highly desirable. The complexity of communication between appropriate hardware currently available is so great that it was not considered possible in the context of this research. However, the modularity of PLUS VAL allows it to be amended to incorporate such improvements in the future.

(vii) Some participants were concerned about some evidence of business value. Their criterion for business value was that the value of professional time saved through the use of the System should at least equal the cost of acquiring it. Some felt that, though the price had not yet been fixed, the order of prices of similar packages commercially available implied that it would be uneconomical for small builders.

The difficulty of providing a rigorous financial justification for information technology has been discussed in Chapter 13. Keen and Woodman (18) admit this difficulty and suggest that simply listing the potential benefits may be a useful alternative.

Benefits which could accrue from the System include:

* Work eliminated: Most traditional clerical work associated with the System are eliminated.

* Costs avoided: Cost of professional time used in:

. carrying out the calculations involved

. storing and retrieving information

. communicating information

. chasing after information from other divisions

* Improved decision-making: Data can be manipulated to answer questions which affect performance.

* Return on time: For example, reduction of time lag between measurement and payment.

* Competive Edge: It is good strategy to acquire the System for use for the purpose of organisational learning. The technology could get to a stage where tenders are sent out on computer media. An organisation which had never had some familiarization with the technology would certainly be at a disadvantage.

* Quality of life at work: The removal of tedium from the job content of construction personnel will allow them to apply their efforts where it is likely to improve performance.

* Spin-offs: For example, a good image to the public.

15.3 COMPARISON OF PLUS VAL WITH SIMILAR SYSTEMS COMMERCIALLY AVAILABLE

A postgraduate student (240) on an M.Sc. (Construction) course carried a comparison of PLUS VAL against similar systems commercially available for four months. He sent out questionnaire to the owners of similar systems identified from catalogues (192, 193) of commercial software. The responses are summarised in Table 15.1.

From the responses received the following remarks may be made:

(i) There are several software for valuations which electronically receive data from packages for estimating.

(ii) The only package which integrates estimating valuations, planning, and cost control is not based on a bill of quantities but a schedule of activities. There is very little indication that the abolition of the bill of quantities anticipated by the designers of that system will take place in the near future. It follows therefore that it would be of little applicability to the more usual type of construction contracts without prior manual building of activities from the contract bills.

PLUS VAL has the advantage in being by far more versatile as to the form of the bill of quantities for it provide the following facilities:

Table 15.1: Comparison of PLUS VAL with Similar Packages Commercially Available.

System Source	Product Name	Conditions of Contract		Mode			Bill Data Input		Method of Measurement		Price Adjustment Method			Materials Control		
		ICE	JCT	Batch	Menu-Driven	Command Driven	Manually	Estimating Package	CESMM	SMM6/7	Baxter	Series 2	Tradi-tional Variation of Price	Amount of material determined auto-matically	Amount of required materials determined auto-matically	Manage-ment of orders and supplies provided
Project Software	PCM-COSTON	*	*		*		*	*	*	*						
Quoin Computing Ltd		*	*		*			*	*	*		*		*		
C-QS Computer Services	NEDO	*	*		*	*	*	*	*	*		*		*		
DBS Ltd			*		*			*		*			*	*		
FCG Ltd	Valuations	*	*		*		*	*	*	*						
Manifest	Estimating & Valuations	*	*		*		*	*	*	*	*	*		.*		
Diouglas Moore	VS	*	*		*		*		*	*	*	*				
NTCS	Valuations PROJ MON		*	*			*		*	*		*	*			
Loughborough University	PLUS VAL	*	*		*		*	*	*	*	*	*	*	*	*	*

Table 15.1: (Continued)

System Source	Product Name	Heads of Valuation Calculation					Claims Calculation			Dayworks			Unfixed Material	
		B.Q. Items	Claims	Daywork	Materials On site	Variation	Inside System	Outside System	Stores Details of Resources	Stores Daywork Sheets	Inside System	Outside System	Calculation Inside	Calculation Outside
Project Software	PCM-COSTON	*	*	*	*			*				*		*
Quoin Computing Ltd		*												
C-QS Computer Services	NEDO	*	*	*				*	*	*	*			
DBS Ltd		*											*	
FCG Ltd	Valuations	*	*				*							
Manifest	Estimating & Valuations	*	*	*	*		*	*	*		*	*	*	*
Douglas Moore	VS	*	*	*	*	*		*				*	*	
NTCS	Valuations PROJ MON	*						*		*			*	
Loughborough University	PLUS VAL	*	*	*	*	*	*	*	*	*	*	*	*	*

Table 15.1: (Continued)

		Measurement of Main Work											
		Individual Bill Items				A Group of items not necessarily in sequence				Portion of Bill 1st and last items being input	Activities		
System Source	Product Name	Quantity Input	Dimen-sions Input	Total Value Input	% Complete Input	Quantity Input	Dimen-sion Input	Total Value Input	% Complete Input	% Complete	Quantity Input	Values Input	% Complete Input
Project Software	PCM-COSTON	*		*									
Quoin Computing Ltd		*	*	*	*	*		*	*	*			
C-QS Computer Services	NEDO	*	*	*	*	*	*	*	*	*			
DBS Ltd			*				*				*		
FCG Ltd	Valuations	*		*	*	*		*	*				
Manifest	Estimating & Valuations	*		*	*						*	*	*
Diouglas Moore	VS	*		*	*							*	*
NTCS	Valuations PROJ MON			*				*			*		
Loughborough University	PLUS VAL	*	*	*	*	*	*	*	*	*	*	*	*

* it can electronically build up a schedule of activities out of the bill of quantities;
* the schedule of activities created is updated automatically when variation orders occur;
* measurement of bill items can be aggregated into measurement of activities automatically;
* measurement of activities can be broken down (i.e. 'unscrambled') into measurements of the component bill items on an averaging basis.

(iii) Most of the valuations systems carried out valuations of measured work in only three ways: by entering quantities, values or percentages of bill items completed period by period. Visits to contractors' sites as well as consultations with contractors undertaken as part of this research indicated that in many cases the type of valuations' data available demanded a variety of other ways for which PLUS VAL provide facilities. These additional ways of measuring and valuing work include:

* entry of dimensions,
* as cost-related items,
* as cost-related activities,
* assessment of lump sums required to complete items or activities,
* entry of quantities, values, or percentages of activities,
* as a calculator (e.g. for determining the net

total of many quantities or values pertaining to same item or activity)

* entry of percentages to be applied to all items in identified pages of the Bill of Quantities.

(iv) Most of the Systems carry out only some of the calculation and depend on a manual completion of the valuation. PLUS VAL can carry out all the calculations up to producing payment certificates for onward transmission to the Architect/Engineer.

(v) For a few of the packages it was claimed that some level of integration of the management functions has been accomplished but in no case was the level of integration achieved or provided for by PLUS VAL: integration of estimating, planning, cashflow, valuations, cost control, purchasing management, and accounting.

In summary it may be said that the need for integration of software for construction management is being increasingly recognized by their users and developers. Some attempts are being made albeit in an 'ad hoc' manner. Within the limitations of the survey carried out with PLUS VAL, in its current state together with provisions for future addition, is potentially the most comprehensive and integrated System of its kind in the United Kingdom at the moment.

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* entry of percentages to be applied to all items in identified pages of the Bill of Quantities.

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In summary it may be said that the need for integration of software for construction management is being increasingly recognized by their users and developers. Some attempts are being made albeit in an 'ad hoc' manner. Within the limitations of the survey carried out with PLUS VAL, in its current state together with provisions for future addition, is potentially the most comprehensive and integrated System of its kind in the United Kingdom at the moment.

CHAPTER SIXTEEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter contains a summary of the research, the conclusions and proposals for further research.

16.1 SUMMARY OF FINDINGS

The summary is described below.

16.1.1 LACK OF INTEGRATION

The causes of lack of integration include:

* technical limitations of computer hardware,
* segregated education, training and experiential exposure of functional groups involved in construction,
* development of software by people who do not possess the necessary expertise,
* the structure and custom-oriented nature of the construction industry leading to inadequate research and specifications of its needs and poor application of research findings.

Details of these causes are discussed in Chapters 2 and 3.

16.1.2 SYSTEMS DEVELOPMENT METHODOLOGY

The methodology found to be appropriate for developing the System involved iterations of the following:

* systems investigation and analysis,
* systems design,
* development of software,
* testing and assessment of the System.

The methodology is described in detail in chapter 2.

15.1.3 THE OPERATIONS OF THE MANAGEMENT

The findings of the study of the operations are described in detail in Chapter 5 - 12. The main findings are as follows:

(i) The methods of carrying out the various functions vary from firm to firm and from project to project.

(ii) In many cases they share common sources of data and provide data to each other .

(iii) The valuations function is important for the following reasons:

* it controls the firm's cashflow;
* it provides data for financial accounting;
* it provides data for management accounting;

(iv) There are six main heads of valuations:

* valuation of work on the basis of the BOQ directly,
* valuation of dayworks,
* valuation of claims,
* valuation of unfixed materials,
* calculation of price fluctuation adjustment,

* calculation of retention.

(v) valuation of work on the basis of the BOQ involves measurements and assessment of individual bill items, pages and portions of the BOQ and activities completed.

16.1.4 THE REQUIREMENTS OF INTEGRATION

They are:

* the establishment of a suitable WBS,
* the use of a common WBS,
* the WBS is simple and is understood by all participants,
* a reasonable number of work packages,
* the use of consistent data.

These requirements are justified in Chapter 12.

16.1.5 SYSTEMS SPECIFICATION

The main requirements summarized from Chapter 13 are:

(i) The system should support valuations, purchasing management and cost control

(ii) User interfaces should be appropriate to the:

* type of user,
* the functions supported by the system,
* the hardware configuration.

(iii) The system should produce all the reports usually produced by the valuations, and materials' and sub-contractors' control functions.

(iv) Input should be via a QWERTY Keyboard and data entry should be the minimum, inexpensive and simple.

(v) The system should store all the data generated by the operations of the contractor which will be required for producing the reports.

(vi) The system should provide the facilities to assist valuations, purchasing management and cost control.

16.1.6 SYSTEM'S DESCRIPTION

PLUS VAL supports valuations, purchasing management, and cost control. It is capable of being implemented as a stand along system or as a link to suitable software.

PLUS VAL is written in FORTRAN 77 and is currently implemented on a PRIME 750 computer.

16.1.7 TESTING OF THE SYSTEM

Tests carried out and described in Chapter 15 showed that PLUS VAL:

* carries out all calculations correctly
* complies with its specification.

16.1.8 ASSESSMENT OF THE SYSTEM

The assessment described in Chapter 15 showed that PLUS VAL:

* provides all the facilities for valuations materials control, and the control of sub-

contractors that potential users wanted;

* covers all the methods of operations of companies contacted;
* is more comprehensive than any of the packages surveyed;
* achieves integration of estimating, valuation, purchasing management and cost control and provides the following benefits:
  . reduced costs of data capture,
  . better use of computer storage,
  . reduced turn around times of data processing,
  . increased data consistency,
  . increased flexibility.

Chapter 15 contain the details of the assessments.

16.1.9 INTEGRATION OF CONTRACT INFORMATION

From the assessment contained in Chapter 15, it is apparent that PLUS VAL amply demonstrates the possibility of integrating estimating, valuations, purchasing management and cost control and of thereby providing the desired benefits.

16.1.10 FURTHER INTEGRATION

PLUS VAL makes provisions for further linking with the following functions:

* Planning,
* Cashflow,
* Costing,

* Plant Management,
* Accounts,

The provisions are discussed in Chapter 15.

16.1.11 FINANCIAL JUSTIFICATION OF THE SYSTEM

Financial justification of the System is inherently difficult because some costs and benefits are not quantifiable. However a method of justification based on the quantifiable costs and benefits is proposed. This involves first calculating the minimum man hours which must be saved through the use of the System to absorb all the quantifiable costs. The second step involves determining the actual time saved by the System and comparing the two times. The intangibles may then be considered before a decision taken as to whether or not to adopt the System.

The System has not been used enough for any reliable time savings to be determined. However it is very apparent that significant time savings can be made on the following tasks:

* data capture,
* retrieval of information,
* calculations,
* preparing reports.

Less quantifiable benefits accrue from:

* improved quality of information which may improve decision making processes,
* the ease of manipulating data held by the System to produce a variety of information.

Details of this subject are provided in Chapter 15.

16.1.12 USER SUPPORT REQUIREMENTS

It was found that there is a tendency for some intended users of systems to resist their implementation and/or use. To overcome such resistance as well as to enable the user to derive maximum benefit from the System the following types of support should be available when required:

* manuals (Users' and Programmers' documents),
* circulars,
* training,
* job redesign,
* policies/persuasion,
* user participation,
* full commitment of management.

Details of user support requirements are discussed in Chapter 4.

16.1.13 THE SIGNIFICANCE OF THE RESEARCH

The research has produced a system which:

* integrates estimating, valuations, purchasing management and cost control,
* provides a framework for integration with the operations of the other management functions;
* satisfies the requirements of its intended users contacted;
* is more comprehensive than any of the similar packages surveyed,
* has tremendous potential for commercial viability.

The System amply demonstrates that computer technology and systems concepts can be used to produce the effective integrated management information systems which are required to meet the increasing challenges of the management of construction contracts.

The achievement of integration implies the factors inhibiting it can be overcome.

16.2 DESIRABLE ENHANCEMENTS TO THE SYSTEM

Feedback from the assessment indicate that the following enhancements are desirable:

(i) There is a need to provide alternatives to the menus for the benefit of more experienced users. Alternatives suggested include commands and forms

(ii) The System should be implemented on micro-computers. The transportability of micros allows for convenience in using the System at site and would also make it more available to the smaller contractors and builders.

(iii) User support requirements such as manuals and training guides should be drawn up.

16.3 FUTURE RESEARCH

Areas of further research identified by this research are:

(i) The main drawback of this System and most other software for construction management is the monster of data entry. Computer technology may have solved the problem of unremitting drudgery of calculations, filing and report generation but it has also supplanted it with a drudgery of its own: data entry. One of the arguments for integration discussed in Chapter 12 was the need to reduce the task of data entry by allowing the use of common data files by the various functions and allow one function to provide data to another directly.

However integration does not still solve the need to key the following types of data from paper into the System on a recurring basis.

* site measurement data,
* dayworks sheets,
* timesheets,
* materials inventories.

One of the points raised at demonstrations was the desirability of recording such data directly into a computer medium which is accessible to the System instead of first recording them on paper. Research with a view to satisfying this desire should be carried out.

(ii) There are some situations in the operation of the System where the user is compelled to interpose a 'human interface'. An example is where the user has to prove that he is entitled to a claim. This involves mental processes for which conventional software are not appropriate substitutes. Research into expert systems is intended to provide tools for this type of task. The possibility of providing an expert system interface in such situations should be investigated.

(iii) Provisions for total integration of contract information have been made in PLUS VAL. This has been done by building facilities in PLUS VAL which allow the maintenance of the following files:

* the BOQ file,
* activities file,
* work packages files,
* valuations file,
* the file of costs data for resource.

The linking of the BOQ, activities, and work packages has established the common WBS which is necessary for total integration.

Functions and sub-functions not currently fully supported by PLUS VAL and which require data contained in the files listed above include:

* Planning,
* Cashflow,
* Costing of Labour and plant,
* Accounts,
* Plant management.

The details of full integration should be studied with a view to obtaining a total integrated contract information management system.

(iv) There appears to be little research on the formulation of contractors' policies as to aspects of computer technology such as:

* type of hardware to buy,
* how to justify the acquisition of any particular software system,
* at what price to sell software developed.

There is a need to address this situation.

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APPENDIX 1: RICS Standard Valuation Form

Valuation

Quantity Surveyor,
of

Architect/S.O.
of

Employer
of

Contractor
of

Works
at

No:

Date

QS Reference

I/We have made, under the terms of the Contract, an Interim valuation as at

* and I/we report as follows:—

Gross valuation [including nominated sub-contractors' values from attached statement *] £

Less the value of any work or material notified to me/us by the Architect/S.O. in writing, as not being in accordance with the Contract £

£

Less retention—either [~~% of £~~ *] £

—or [from attached statement *] £

£

Less previously CERTIFIED £

£

Balance (in words) £

Contract sum £

Signature: Quantity Surveyor.

Notes:

(i) All the above amounts are exclusive of V.A.T.

(ii) The balance stated is subject to any statutory deductions which the Employer may be obliged to make under the provisions of the Finance (No. 2) Act 1975 where the Employer is classed as a "contractor" for the purposes of the Act

(iii) It is assumed that the Architect/S.O. will —

(a) satisfy himself that there is no further work or material which is not in accordance with the Contract.

(b) ~~unless otherwise agreed~~, notify Nominated sub-contractors of payments due to them.

(c) satisfy himself, ~~[illegible]~~ that previous payments to Nominated sub-contractors have been discharged.

(iv) The Certificate of payment should be issued within seven days of the date indicated thus*.

(v) Action by the Contractor should be taken only on the basis of figures contained in the Certificate of payment.

* Delete as appropriate.

						£	ADDITIONS £	p
	AI	No.5:	Provide granolithic finish to Specification Clause G8/77 on all top surfaces.					
	ISSUED:		5/3/86					
	MEASURED:		11/3/86					
	ADDITIONS							
2/	2.50		Granolithic finishing 55mm thick with steel trowel finish					
	8.00	40.00						
½/	9.00							
	1.50	6.75						
	27.00							
	2.00	54.00						
5/	10.00							
	0.50	2.50						
		103.25		2/17	103.25	10.00	10325	00

APPENDIX 3: Method B of recording Variations

AI	NO.	5	Provide granolithic finish to Specification Clause G8/77 on all top surfaces
ISSUED:		5/3/86	
MEASURED:		11/3/86	
ADDITIONS			
2/	2.50		
	8.00	40.00	
½/	9.00		
	1.50	6.75	
	27.00		
	2.00	54.00	
5/	10.00		
	0.50	2.50	
		103.25	

XYZ CONSTRUCTION LTD

CONTRACT M999 MOTORWAY

Work Started 13/4/86 Dayworks Sheet No. 11 Date 13/4/86

Work Completed 13/4/86 Dayworks Sheet Code EIN/89

AI No 3 Maintain bridge on Derby Rd as per letter Ref. No. XYZ/86/127

LABOUR	HRS	RATE	£	P	MATERIALS	QTY	RATE	£	P
Mike Haines-painter	8	12.00	96	00	Gloss Paint	2 litres	5.00	10	00
Ted Foster-driver	8	10.00	80	00	Aggregates	5t	13.00	65	00
Mal Tagg-labourer	6	7.50	45	00	Sand	5t	11.00	55	00
Seb Willis-mason	8	13.00	104	00	O.P. Cement	5 bags	3.00	15	00
Ron Beeston-operator	8	10.50	84	00				145	00
			409	00					
PLANT									
Tipper Lorry-XYZ.97	6	7.00	42	00					
Concrete Mixer-XYZ.12	8	5.00	40	00					
			82	00					

Site Agent's Representative ____________ Architect's Representative ____________

APPENDIX 5: Sample Statement of Retention and of Nominated Sub-Contractors' Values

CONTRACT ______________ DATE ______________ VALUATION NO. ______________

	GROSS VALUATION	AMOUNT SUBJECT TO			AMOUNT OF RETENTION	NET VALUATION	AMOUNT PREVI-OUSLY CERTIFIED	BALANC
		FULL RETENTION	HALF RETENTION	NO RETENTION				
Main Contractor	257 800	150 000	87 500	20 300	5 812	251 988	180 700	71 288
Nominated Sub-Contractors								
1 Ohms Electrics Ltd	78 700	78 700	-	-	2 361	76 339	20 800	55 539
2 Dawson Roofing Ltd	45 000	45 000			1 350	45 650	15 500	28 150
3 Wagstaff Plumbers Ltd	55 000	-	55 000		825	54 175	40 900	13 275
4 Skyways Furniture Ltd	25 000	-	-	25 000	-	25 000	25 000	-
5 XYZ Lanscraping Ltd	13 700	23 700			771	22 929	-	22 929
TOTAL	485 200	297 400	142 500	45 300	11 119	474 081	282 900	191 181

APPENDIX 6: Example of the Quantification of General Overheads by "The Assessment of 'Variable' Notional Preliminaries" Method.

Assume that the analysis of the tender shows the following

(i) The total of preliminaries in the Contract Bills is £400 000 of which 10% are for 'setting up and dismantling of site'.

(ii) The allowance for overheads and profit in the tender was 10%.

(iii) The allowance for inflation was 5%.

(iv) other non-variable (non-recurring) items of preliminaries have a total of £20 000.

The assessment of General Overheads is as follows:

Value of Preliminaries less items for setting up and dismantling site

$$= £400\ 000 - £\left(\frac{10}{110} \times 400\ 000\right)$$

$$= £400\ 000 - £36\ 364$$

$$= £363\ 636$$

Values of Preliminaries less non-variable items

$$= £363\ 636 - £20\ 000$$

$$= £343\ 636$$

Allowing for overheads/profits and increased costs,

cost of variable preliminaries

$$= £343\ 636 - £\ 343\ 363 \times \frac{10}{110} - £\ 343\ 636 \times \frac{5}{105}$$

$$= £343\ 636 - £31\ 240 - £16\ 364$$

$$= £296\ 032$$

If contract period is 60 weeks,

$$\text{Cost/week} = \frac{£296\ 032}{60\ \text{weeks}} = £4934$$

If the percentage for overheads is 7½% then the value of overheads $= £\ \frac{7.5}{100} \times £4934$ /week

$= £370/\text{week}$

APPENDIX 7: A Sample Materials Fluctuation Payment Request

MATERIALS FLUCTUATION CLAIM

MATERIAL: Engineering Bricks Class A

SHEET NO. 5

BASIC PRICE: £160/Thousand

SUPPLIERS	INVOICE NO	DATE	QUANTITY	INVOICE PRICE	DECREASE		INCREASE		TOTAL DECREASE		TOTAL INCREASE	
Redsea Bricks Ltd			Thou-sands	£	£	p						
1	PT 711	5/3/84	500	161.00			1	00			500	00
2	PT 712	20/4/85	120	161.50			1	50			180	00
3	PT 713	25/6/85	200	161.50			1	50			300	00
4	PT 714	1/10/85	250	162.00			2	00			500	00
5	PT 715	13/12/85	300	162.00			2	00			600	00
									-	-	2080	00
											2080	00

APPENDIX 8: LIST OF WORK CATEGORIES FOR THE NEDO SERIES 2 INDICES

2/1	Demolitions
2/2	Site preparation, excavation and sisposal
2/3	Hardcore and imported filling
2/4	General piling
2/5	Steel sheet piling
2/6	Concrete
2/7	Reinforcement
2/8	Structural precast and prestressed concrete units
2/9	Non-structural precast concrete components
2/10	Formwork
2/11	Brickwork and blockwork
2/12	Natural stone
2/13	Asphalt work
2/14	Slate and tile roofing
2/15	Asbestos, cement, sheet roofing and cladding
2/16	Plastic coated steel sheet roofing and cladding
2/17	Aluminium sheet roofing and cladding
2/18	Build-up felt roofing
2/19	Build-up felt roofing on metal decking
2/20	Carpentry, manufactured boards and softwood flooring
2/21	Hardwood flooring
2/22	Tile and sheet flooring(vinyl, thermoplastic, linoleum and other synthetic materials)
2/23	Jointless Flooring (epoxy resin type)
2/24	Softwood joinery
2/25	Hardwood joinery
2/26	Ironmongery
2/27	Steelwork
2/28	Steel windows and doors
2/29	Aluminium windows and doors
2/30	Miscellaneous metalwork
2/31	Cast iron pipes and fittings
2/32	Plastic pipes and fittings
2/33	Copper tubes, fitting and cylinders
2/34	Mild steel pipes, fittings and tanks

2/35 Boilers, pumps and radiators
2/36 Sanitary fittings
2/37 Insulation
2/38 Plastering (all types) to walls and ceilings
2/39 Beds and screeds (all types) to floors, roofs and pavings
2/40 Dry partitions and linings
2/41 Tiling and terrazzo work
2/42 Suspended ceilings (dry construction)
2/43 Glass, mirrors and patent glazing
2/44 Decorations
2/45 Drainage pipework (other than cast iron)
2/46 Fencing, gates and screens
2/47 Bituminous surfacing to roads and paths
2/48 Soft landscaping

APPENDIX 9: Standard Form for the Completion of the Schedule of Fluctuations

Allocation of bill of quantities items to work categories

Contract No. ______________________ Employer ______________________

Project ______________________ Contractor ______________________

Bill of quantities No.	2

Cat. No. 2/	Bill of quantities item reference	Amount £
1	—	—
2	Page 2/1 Items A-J inc., Page 2/2 Items B to K inc., etc.	7996
3	Page 2/1 Item K, Page 2/2 Item L, Page 2/3 Item A, etc.	3219
4	—	—
5	—	—
6	etc.	38925
7	etc.	22511
8		—
9		3425
10		24591
11		19070
12		—
13		—
14		—
15		—
16		—
17		—
18		8793
19		—
20		13253
21		—
22		715
23		—
24		7079
25		2488
26		389
	Total to overleaf £	152454

APPENDIX 9: (Continued)

		Total from overleaf £	152454
27			1679
28			—
29			663
30			439
31			—
32			285
33			341
34			—
35			—
36			902
37			—
38			1880
39			893
40			—
41			—
42			1259
43			8469
44			5784
45			—
46			—
47			—
48			—
		Total £	175048
Provisional sums to which formula *will* apply	Page 108 Items A-F inc.		7600
		Total L £	182648
Provisional sums to which formula will *not* apply (including dayworks)	Page 108 Item G	Total M £	2250
PC sums (including main contractor's profit)	Page 107 Items A-G inc.	Total N £	123400

APPENDIX 9: (Continued)

(Part 1) **Summary of Form A**

Contract No. ____________________ Employer ____________________

Project ____________________ Contractor ____________________

Bill of quantities No.	Work allocated to categories and provisional sums to which formula will apply (Total L Form A)	Provisional sums to which formula will not apply (including daywork) (Total M Form A)	PC sums including main contractor's profit (Total N Form A)
1	—	17000	—
2	182648	2250	123400
3	127664	2400	86800
4.	30256	1250	—
5			
6			
7			
Totals £	X 340568	Y 22900	Z 210200

(Part 2) **Calculation of balance of adjustable work**

	Contract sum (before deduction of credit for old materials)		£	625668
Deduct (i)	Provisional sums to which formula will *not* apply (including dayworks) — Total Y above	£ 22900		
(ii)	PC sums (including main contractor's profit) — Total Z above	£ 210200		233100
	Total of contract sum properly subject to price adjustment		£	392568
Deduct	Value of work allocated to work categories, and provisional sums to which the formula *will* apply — Total X above		£	340568
	Balance of adjustable work		£	52000

APPENDIX 10: LISTING OF THE NEDO INDEX GROUPINGS FOR CIVIL ENGINEERING WORK

(A) GENERAL CIVIL ENGINEERING WORK

1. Labour and supervision
2. Plant and road vehicles: provision and maintenance
3. Aggregates
4. Bricks and Clay products
5. Comments
6. Cast iron products
7. Coated roadstone for road pavements and bituminous products
8. Derv fuel
9. Gas oil fuel
10. Timber

11A. Steel for reinforcement

11A. Metal Sections

12. Fabricated Structural Steel

(B) STRUCTURAL STEELWORK

1. Fabrication labour
2. Erection labour

APPENDIX 11: Sample Calculations of Fluctuations

PRICE FLUCTUATION FACTOR FOR 2/84

PRODUCT	CURRENT INDEX	BASE INDEX	DIFFERENCE	DIFF./BASE	PROPORTION	FACTOR
1	507.0	507.0	0.0	0.00000000	0.10	0.00000000
2	477.6	476.8	0.8	0.00167783	0.01	0.00001678
3	759.6	756.4	3.2	0.00423050	0.10	0.00042305
4	788.6	788.6	0.0	0.00000000	0.10	0.00000000
5	645.6	645.6	0.0	0.00000000	0.10	0.00000000
6	624.3	624.3	0.0	0.00000000	0.10	0.00000000
7	919.9	919.9	0.0	0.00000000	0.10	0.00000000
8	550.1	550.1	0.0	0.00000000	0.10	0.00000000
9	1237.9	1237.9	0.0	0.00000000	0.10	0.00000000
10	557.0	557.0	0.0	0.00000000	0.09	0.00000000
11	185.7	185.7	0.0	0.00000000	0.10	0.00000000
12	436.3	436.3	0.0	0.00000000	0.00	0.00000000
13	466.2	466.2	0.0	0.00000000	0.00	0.00000000
14	661.7	661.7	0.0	0.00000000	0.00	0.00000000
			PRICE FLUCTUATION FACTOR			0.00043983

PRICE FLUCTUATIONS SUMMARY

VAL	SECTION	MONTH	NON-ADJUSTIBLE	EFF VALUE	PF FACTOR	ADJUSTMENT	TOTAL VALUE
	Main Work	2/84	0.00	399206.67	0.00043983	175.58	399382.25
	ALL WORK	2/84	0.00	399206.67		175.58	399382.25

APPENDIX 12: Sample Payment Certificate

PROJECT:	**CONSTRUCTION OF THE M999 MOTORWAY**
CLIENT	THE DEPARTMENT OF TRANSPORT 12 GREAT GEORGE STREET, WESTMINSTER, LONDON 1NV 8TY
CONSULTANT:	GUGGISBERG AND PARTNERS 34 COLCHESTER ROAD, BURNT OAK, EDGWARE, MIDDX HA8 ORA
CONTRACTOR:	BONNY AND SONS LTD. 86 STROUDGREEN ROAD, FINSBURY PARK, LONDON N.4
TENDER TOTAL:	55754321.00

INTERIM PAYMENT CERTIFICATE NO. 1

Value of measured works to date using Bill rates	399206.67
Price Fluctuations Adjustment	175.58
Net Value of Measured Works to date	399382.25
Total Dayworks account to date	58943.40
Unfixed Material on/off site	433846.83
Value of claims accepted to date	32500.00
Gross Amt.	919672.48
Total Retention held	48582.56
Net Valuation	871089.92
Total amount previous certified	0.00
Amt now due to Contractor	871089.92

Resident Engineer

Engineer

APPENDIX 13: Sample Statement of Retention and of Nominated Sub-Contractors' Values

STATEMENT OF RETENTION AND NOMINATED SUBCONTRACTORS VALUES

		AMOUNT SUBJECT TO:						
	GROSS VALUE	FULL RETENTION	HALF RETENTION	NO RETENTION	AMOUNT OF RETENTION	NET VALUATION	PREVIOUS AMOUNT	BALANCE
MAIN CONTRACTOR,	869253.99	435407.16	0.00	433846.83	43540.72	825713.28	0.00	825713.28
Muckshifters Ltd.	2282.05	2282.05	0.00	0.00	228.21	2053.85	0.00	2053.85
Buckingham Roadworks Ltd.	3187.71	3187.71	0.00	0.00	318.77	2868.94	0.00	2868.94
T. H. Tamson & Sons Ltd.	6348.58	6348.58	0.00	0.00	634.86	5713.72	0.00	5713.72
Brunner & Son LTD.	6025.50	6025.50	0.00	0.00	602.55	5422.95	0.00	5422.95
Safeways Demolitions Ltd.	4646.20	4646.20	0.00	0.00	464.62	4181.58	0.00	4181.58
Micawber Painting Works Ltd.	3565.23	3565.23	0.00	0.00	356.52	3208.71	0.00	3208.71
Carl Bentle Construction Ltd.	4365.07	4365.07	0.00	0.00	436.51	3928.56	0.00	3928.56
Hopkins Asphalt Works Ltd.	6560.14	6560.14	0.00	0.00	656.01	5904.13	0.00	5904.13
Douglas Rowe Construction Ltd,	1644.75	1644.75	0.00	0.00	164.48	1480.28	0.00	1480.28
Sir Robert Willoughby Ltd.	11793.26	11793.26	0.00	0.00	1179.33	10613.93	0.00	10613.93
	919672.48	485825.65	0.00	433846.83	48582.56	871089.91	0.00	871089.91

APPENDIX 14: Sample Resource Analysis.

CONTRACTOR: BONNY AND SONS LTD.

CONTRACT: CONSTRUCTION OF THE M999 MOTORWAY

PERIOD: START - 1/ 2/84

RESOURCE ANALYSIS ON PERIOD"S WORK

(B) With Adjustments For Inflation

PACKAGE	DESCRIPTION	LABOUR	PLANT	MATERIALS	SUBCONTRACT	OH/PROFIT
1	Time-related Preliminaries	450.20	675.30	900.40	0.00	225.10
2	Cost-related Preliminaries	3624.61	5436.92	7249.23	0.00	1812.31
3	General Overheads	6903.03	6903.03	13806.07	0.00	6903.03
4	Demolition and Site Clearance	6398.07	9597.11	12796.14	0.00	3199.03
5	Drainage	2515.91	3773.86	5031.82	0.00	1257.95
6	Services	2314.35	3471.52	4628.70	0.00	1157.17
7	Bulk Earthmoving	2002.54	3003.82	4005.09	0.00	1001.27
8	Sub-base Course	2611.43	3917.15	5222.86	0.00	1305.72
9	Base Course	3277.12	4915.68	6554.23	0.00	1638.56
10	Rigid Pavements	5565.92	8348.88	11131.84	0.00	2782.96
11	Flexible Pavements	5822.00	8733.01	11644.01	0.00	2911.00
12	Kerbs	4196.60	6294.90	8393.20	0.00	2098.30
13	Paths and Payement Areas	3507.04	5260.56	7014.08	0.00	1753.52
14	Fencing	5206.61	7809.91	10413.22	0.00	2603.30
15	Topsoiling	5437.05	8155.57	10874.10	0.00	2718.52
16	Grassing	4673.77	7010.65	9347.53	0.00	2336.88
17	Attendance on Nom. Subbies	5262.51	7893.77	10525.02	0.00	2631.26
18	All Sub-contracted Works	0.00	0.00	0.00	50440.66	97.74
	Total	69768.77	101201.64	139537.53	50440.66	38433.64

APPENDIX 14 (Continued)

CONTRACTOR: BONNY AND SONS LTD.

CONTRACT: CONSTRUCTION OF THE M999 MOTORWAY

PERIOD: START - 1/ 2/84

RESOURCE ANALYSIS ON PERIOD"S WORK

(A) Without Adjustments For Inflation

PACKAGE	DESCRIPTION	LABOUR	PLANT	MATERIALS	SUBCONTRACT	OH/PROFIT
1	Time-related Preliminaries	450.00	675.00	900.00	0.00	225.00
2	Cost-related Preliminaries	3623.02	5434.53	7246.04	0.00	1811.51
3	General Overheads	6900.00	6900.00	13800.00	0.00	6900.00
4	Demolition and Site Clearance	6395.26	9592.89	12790.51	0.00	3197.63
5	Drainage	2514.80	3772.21	5029.61	0.00	1257.40
6	Services	2313.33	3470.00	4626.66	0.00	1156.67
7	Bulk Earthmoving	2001.66	3002.50	4003.33	0.00	1000.83
8	Sub-base Course	2610.28	3915.43	5220.57	0.00	1305.14
9	Base Course	3275.68	4913.51	6551.35	0.00	1637.84
10	Rigid Pavements	5563.47	8345.21	11126.95	0.00	2781.74
11	Flexible Pavements	5819.44	8729.17	11638.89	0.00	2909.72
12	Kerbs	4194.75	6292.13	8389.51	0.00	2097.38
13	Paths and Pavement Areas	3505.50	5258.25	7011.00	0.00	1752.75
14	Fencing	5204.32	7806.48	10408.64	0.00	2602.16
15	Topsoiling	5434.66	8151.99	10869.32	0.00	2717.33
16	Grassing	4671.71	7007.57	9343.42	0.00	2335.86
17	Attendance on Nom. Subbies	5260.20	7890.30	10520.39	0.00	2630.10
18	All Sub-contracted Works	0.00	0.00	0.00	50418.49	97.70
	Total	69738.09	101157.15	139476.18	50418.49	38416.75

APPENDIX 15. Sample Page of the Bill Listing

SECTION 1:_GENERAL CONTRACT ITEMS

ITEM CODE	ITEM DESCRIPTION	BILL QUANTITY	UNIT	RATE	AMOUNT
1.A110	PERFORMANCE BOND	15000.00	SUM	1.00	15000.00
1.A120	INSURANCE OF THE WORKS	100000.00	SUM	1.00	100000.00
1.A130	INSURANCE OF CONSTRUCTIONAL PLANT	20000.00	SUM	1.00	20000.00
1.A140	INSURANCE AGAINST DAMAGE TO PERSONS OR PROPERTY	100000.00	SUM	1.00	100000.00
1.A211.1	ESTABLISHMENT OF BUILDING	200000.00	SUM	1.00	200000.00
1.A211.2	MAINTENANCE OF BUILDING	60.00	WK	1000.00	60000.00
1.A219.1	REMOVAL OF BUILDING	10000.00	SUM	1.00	10000.00
1.A219.2	ESTABLISHMENT OF CAE R PARK AND HARDSTANDING	10000.00	SUM	1.00	10000.00
1.A219.3	REMOVAL OF CAR PARK AND HARDSTANDING	5000.00	SUM	1.00	5000.00
1.A219.4	ESTABLISHMENT OF ACCESS ROUTE	20000.00	SUM	1.00	20000.00
1.A219.5	REMOVAL OF ACCESS ROUTE AND REINSTATEMENT OF BOUNDARY WALL & FOOTPATH	10000.00	SUM	1.00	10000.00
T600	CONCRETE 1:2:4 TO FOUNDATIONS	233.15	M3	20.00	4663.09
1.A231.1	ESRTABLISHMENT OF AND REMOVAL OF BUILDING S EQUIPMENT AND FURNITURE	5000.00	SUM	1.00	5000.00
1.A231.2	MAINTENANCE OF BUILDING'S EQUIPMENT AND FURNITURE	60.00	WK	150.00	9000.00
1.A232.1	ESTABLISHMENT AND REMOVAL OF TESTING EQUIPMENT	20000.00	SUM	1.00	20000.00
1.A232.2	MAINTENANCE OF AND SERVICING OF TESTING EQUIPMENT	60.00	WK	2000.00	120000.00
1.A233.1	ESTABLISHMENT AND REMOVAL OF SURVEYING EQUIPMENT	10000.00	SUM	1.00	10000.00
1.A233.2	MAINTENANCE AND SERVICING OF SURVEYING EQUIPMENT	50.00	WK	100.00	5000.00
1.A242.1	ATTENDANCE UPON ENGINEER'S STAFF -CHAINMAN	300.00	HR	100.00	30000.00
1.A250.1	CONC. STRENGTH TESTS AS SPEC. CL. 4.28	75.00	NR	100.00	7500.00
1.A250.2	CONC. WORKABILITY TESTS AS SPEC. CL. 4.28	75.00	NR	100.00	7500.00
Total Carried Forward					768663.09

APPENDIX 16: Sample Page of Listings of Valuations of BOQ Items

SECTION 1: GENERAL CONTRACT ITEMS

BILL QUANTITY	UNIT	RATE	BILL AMOUNT	PREVIOUS QTY	PREVIOUS AMT	QUANTITY NOW	AMOUNT NOW	QTY. TO DATE	AMT. TO DATE
1.A110	PERFORMANCE BOND								
15000.00	SUM	1.00	15000.00	0.00	0.00	750.00	750.00	750.00	750.00
1.A120	INSURANCE OF THE WORKS								
100000.00	SUM	1.00	100000.00	0.00	0.00	5000.00	5000.00	5000.00	5000.00
1.A130	INSURANCE OF CONSTRUCTIONAL PLANT								
20000.00	SUM	1.00	20000.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
1.A140	INSURANCE AGAINST DAMAGE TO PERSONS OR PROPERTY								
100000.00	SUM	1.00	100000.00	0.00	0.00	5000.00	5000.00	5000.00	5000.00
1.A211.1	ESTABLISHMENT OF BUILDING								
200000.00	SUM	1.00	200000.00	0.00	0.00	10000.00	10000.00	10000.00	10000.00
1.A211.2	MAINTENANCE OF BUILDING								
60.00	WK	1000.00	60000.00	0.00	0.00	3.00	3000.00	3.00	3000.00
1.A219.1	REMOVAL OF BUILDING								
10000.00	SUM	1.00	10000.00	0.00	0.00	500.00	500.00	500.00	500.00
1.A219.2	ESTABLISHMENT OF CAR PARK AND HARDSTANDING								
10000.00	SUM	1.00	10000.00	0.00	0.00	500.00	500.00	500.00	500.00
1.A219.3	REMOVAL OF CAR PARK AND HARDSTANDING								
5000.00	SUM	1.00	5000.00	0.00	0.00	250.00	250.00	250.00	250.00
1.A219.4	ESTABLISHMENT OF ACCESS ROUTE								
20000.00	SUM	1.00	20000.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
1.A219.5	REMOVAL OF ACCESS ROUTE AND REINSTATEMENT OF BOUNDARY WALL & FOOTPATH								
10000.00	SUM	1.00	10000.00	0.00	0.00	500.00	500.00	500.00	500.00
Total Carried Forward					0.00		27500.00		27500.00

APPENDIX 17: Samples of Listings of Contract Resources

RESOURCES FILE LISTING

LABOUR

NO.	DESCRIPTION	UNIT	RATES BUDGET	CURRENT	DAYWORK	% ADJ%
1	LABOUR LUMP SUM	SUM	1.00	1.00	1.00	155.0
23	JOHN SMITH -LABOURER	HR	4.16	4.16	4.16	155.0
24	BILL REED -CARPENTER	HR	4.16	4.16	26.00	155.0
25	HAROLD SPELMAN -GANGER	HR	3.12	3.12	3.12	155.0
26	MARK DAVIES -BRICKIE	HR	5.20	5.20	6.00	155.0
29	BRICKLAYER	HR	5.00	5.00	5.00	155.0
30	CARPENTER	HR	5.00	5.00	5.00	155.0
31	LABOURER	HR	5.00	5.00	43.00	155.0
32	PAINTER	HR	5.00	5.00	5.00	155.0
42	CRAFTSMAN	HR	5.00	5.00	5.80	155.0
43	DIESEL ROLLER DRIVER	HR	5.00	5.00	5.00	155.0
49	KEN MACKENZIE	HR	5.00	5.00	5.00	155.0
50	DAVE HIGGS	HR	6.00	6.00	6.00	155.0
51	ROGER PARKINSON	HR	7.00	7.00	7.00	155.0
52	BOB SHEPHERD	HR	7.00	7.00	7.00	155.0
53	GRANT GELLATLY	HR	9.00	9.00	9.00	155.0
54	DERIC LAVELLE	HR	10.00	10.00	10.00	155.0
55	MICHAEL BOUGHEN	HR	19.00	19.00	10.00	155.0

APPENDIX 17 (Continued)

RESOURCES FILE LISTING

PLANT

NO.	DESCRIPTION	UNIT	RATES BUDGET	RATES CURRENT	RATES DAYWORK	% ADJ%
2	PLANT LUMP SUM	SUM	1.00	1.00	1.00	15.0
4	CONCRETE MIXER	HR	12.47	12.47	13.00	15.0
5	LORRY -TIPPER 6 M3	HR	16.37	16.37	16.37	15.0
6	HYMAC 580	HR	6.19	6.19	6.19	15.0
7	PLATE COMPACTOR	HR	1.92	1.92	1.92	15.0
8	BOBCAT 500	HR	7.48	7.48	7.43	15.0
9	COMPRESSOR	HR	2.10	2.10	15.00	15.0
10	955 TRAXCAVATOR	HR	17.78	17.78	17.78	15.0
11	JCB 3C EXCAVATOR	HR	8.84	8.84	22.00	15.0
12	DUMPER 1M3	HR	3.74	3.74	200.00	15.0
13	CONC. MIXER	HR	6.24	6.24	6.24	15.0
14	TOWER CRANE	HR	15.59	15.59	15.59	15.0
28	SCRAPER	HR	30.00	30.00	30.00	15.0
46	DIESEL ROLLER	HR	10.00	10.00	10.00	15.0
47	BITUMEN DISTRIBUTOR	HR	30.00	30.00	30.00	15.0
48	LOW LOADER	HR	100.00	100.00	100.00	15.0

APPENDIX 17 (Continued)

RESOURCES FILE LISTING

MATERIALS

NO.	DESCRIPTION	UNIT	RATES BUDGET	CURRENT	DAYWORK	% ADJ%
3	LUMP SUM FOR MATERIALS	SUM	1.00	1.00	1.00	15.0
15	6MM M.S. REBAR	TNNE	311.85	311.85	311.85	15.0
16	10MM M.S. REBAR	TNNE	311.85	280.00	320.00	15.0
17	12MM M. S. REBAR	TNNE	280.00	280.00	285.00	15.0
18	10MM H.T. REBAR	TNNE	250.00	250.00	251.00	15.0
19	20MM H.T. REBAR	TNNE	250.00	250.00	252.00	15.0
20	MESH B.S. REF B196	M2	0.88	0.88	25.00	15.0
21	PLYWOOD(EXT) 12MM	M2	3.60	3.60	3.60	15.0
22	GRANULAR FILL	M3	8.42	8.42	8.42	15.0
27	SAND	KG	7.00	8.00	8.00	155.0
33	FACING BRICKS	THOU	74.00	74.00	74.00	15.0
34	450 * 225 * 100 MM THERMALITE BLOCKS	NO.	0.50	0.50	0.50	15.0
35	MORTAR	M3	20.00	20.00	20.00	15.0
36	112 mm DAMPCOURSE	M	0.30	0.30	0.30	15.0
37	STEEL CAVITY LINTEL,1500mm	NO	15.00	15.00	15.00	15.0
38	838 * 1981 mm EXT. QUALITY PLYFACED FLUS	NO	50.00	50.00	50.00	15.0
39	DOOR FRAME SET	NO	20.00	20.00	20.00	15.0
40	UNDERCOAT PAINT	LITR	10.00	10.00	41.00	15.0
41	GLOSS PAINT	LITR	10.00	10.00	10.00	15.0
44	40mm TARMACADAM	KG	0.90	100.00	55.00	15.0
45	12mm FINE TARMACADAM	KG	0.90	5.00	5.00	15.0
56	COATED ROADSTONE	TNNE	23.91	24.00	24.00	15.0
57	SUM FOR MISCELLANEOUS MATERIALS	SUM	1.00	1.00	1.00	15.0
58	PORTLAND CEMENT TO BS12	TNNE	48.76	48.76	50.00	15.0

APPENDIX 18: A Sample Priced Dayworks Sheet

CONTRACTOR: BONNY AND SONS LTD.

CONTRACT: CONSTRUCTION OF THE M999 MOTORWAY

DAYWORK SHEET NO. 1

DATE COMMENCED: 4 /4 /85
DATE COMPLETED: 4 /4 /85
INSTRUCTION NO. 1
TASK: REINSTATEMENT OF BRIDGE AT CH 1256 + 79

LABOUR

RESOURCE NO.	DESCRIPTION	QUANTITY	UNIT	COST	OH/PROFIT(%)	AMOUNT
23	JOHN SMITH -LABOURER	8.00	HR	4.16	150.0	83.16
32	PAINTER	8.00	HR	5.00	150.0	100.00
42	CRAFTSMAN	6.00	HR	5.80	150.0	87.00
	TOTAL LABOUR					270.16

PLANT

RESOURCE NO.	DESCRIPTION	QUANTITY	UNIT	COST	OH/PROFIT(%)	AMOUNT
5	LORRY -TIPPER 6 M3	8.00	HR	16.37	15.0	150.62
9	COMPRESSOR	5.00	HR	15.00	15.0	86.25
12	DUMPER 1M3	8.00	HR	200.00	15.0	1840.00
	TOTAL PLANT					2076.87

MATERIALS

RESOURCE NO.	DESCRIPTION	QUANTITY	UNIT	COST	OH/PROFIT(%)	AMOUNT
22	GRANULAR FILL	100.00	M3	8.42	15.0	968.29
40	UNDERCOAT PAINT	150.00	LITR	41.00	15.0	7072.50
41	GLOSS PAINT	235.00	LITR	10.00	15.0	2702.50
	TOTAL MATERIALS					10743.29

TOTAL FOR DAYWORK SHEET NO. 1 — 13090.33

APPENDIX 19: A Sample Summary of Dayworks

CONTRACTOR: BONNY AND SONS LTD.

CONTRACT: CONSTRUCTION OF THE M999 MOTORWAY

DAYWORKS ACCOUNTS -VALUATION NO. 1

SHEET NO.	DESCRIPTION	LABOUR	PLANT	MATERIALS	OTHER	SUBCONTRACT	OH/PROFIT	TOTAL
1	REINSTATEMENT OF BRIDGE AT CH 1256 + 79	108.06	1805.98	9341.99	0.00	0.00	1834.29	13090.33
2	REMOVE WINDOW AND FIX DOOR	108.95	0.00	2035.00	0.00	0.00	468.67	2612.62
3	REMOVE AND RELAY PIPE AS BY DWG NO. LUT/86	87.20	190.00	0.00	0.00	0.00	159.30	436.50
4	ATTENDANCE ON ROOFING SUBCONTRACTOR	118.40	124.74	0.00	0.00	0.00	196.31	439.45
5	EXTENSION OF EXISTING BOUNDARY WALL	289.26	1252.00	8400.00	0.00	0.00	1881.70	11822.96
	ALL DAYWORKS	711.88	3372.72	19776.99	0.00	0.00	4540.27	28401.86

APPENDIX 20: A Sample Valuation of Unfixed Materials

UNFIXED MATERIALS -VALUATION NO. 1

MAT. NO.	DESCRIPTION	UNIT	QUANTITY	RATE	PROPORTION	AMOUNT
15	6MM M.S. REBAR	TNNE	421.00	47.00	100	19787.00
16	10MM M.S. REBAR	TNNE	195.00	280.00	100	54600.00
17	12MM M. S. REBAR	TNNE	680.00	280.00	100	190400.00
18	10MM H.T. REBAR	TNNE	400.00	250.00	100	100000.00
19	20MM H.T. REBAR	TNNE	75.00	250.00	100	18750.00
22	GRANULAR FILL	M3	533.00	8.42	100	4487.83
27	SAND	KG	344.00	8.00	100	2752.00
33	FACING BRICKS	THOU	120.00	74.00	100	8880.00
40	UNDERCOAT PAINT	LITR	600.00	10.00	100	6000.00
41	GLOSS PAINT	LITR	940.00	10.00	100	9400.00
56	COATED ROADSTONE	TNNE	275.00	24.00	100	6600.00
58	PORTLAND CEMENT TO BS12	TNNE	250.00	48.76	100	12190.00

Total payment due for Unfixed Materials 433846.83

APPENDIX 21: Squaring of Dimensions by PLUS VAL

DIMENSIONS FOR VALUATION NO. 1
==============================

2.L110			EXCAVATION OF ROCK
2/	1.30 3.00 1.00		
	------------		(near borehole
		7.80	
	1.70 0.80 0.50		

		0.68	
3.143/	2.00 2.00 2.00		
	------------		(cylindrical col
		25.14	
	1.20 0.30 4.10		

		1.48	
2/3/	1.00 2.00 3.00		

		36.00	
TOTAL QUANTITY TO DATE		71.10	
		============	
5.T170.1			EXCAVATED SURFACES ,VOID FILLED WITH CEMENT GROUT CLASS G1
2/4/	1.00 2.00		
	------------		(CH 123 + 45
		16.00	
2/	6.00 4.00		

		48.00	
3.143/	2.00 3.00		

		18.86	
TOTAL QUANTITY TO DATE		82.86	
		============	

APPENDIX 22: A Sample of a Bill of Variations

BILL OF VARIATIONS

VARIATION ORDER NO. 1 REPLACE DRAWING NO. LUT/12 WITH DRAWING NO. LUT/27

DATE ISSUED: 21/1 /86

					UNIT	QUANTITY	RATE	ADDITIONS	OMISSIONS
F150				PROVIDE AND PLACE CONCRETE GRADE 30/20	M3	195.00	15.00		2925.00
F150.1	2/	2.00 2.00 2.00	16.00	PROVIDE AND PLACE CONC. GRADE 22.5/37.5					
	2/5/	1.50 1.80 2.10	56.70						
		2.00 5.20 1.90	19.76						
	3.143/0.25/	3.00 3.00 3.00	21.22						
	9/	1.00 3.00 5.00	135.00						
	0.5/	4.50 1.30 2.90	8.48						
			257.16		M3	257.16	20.00	5143.16	
2.L160.1				BACKFILLING PIPE TRENCH WITH IMPORTED MATERIAL AS SPEC CL 2.72	M3	810.00	2.49		2016.90
								5143.16	4941.90

APPENDIX 23: A Sample of a Summary of Claims

CLAIMS SUMMARY

CLAIM NO.	DESCRIPTION	LABOUR	PLANT	MATERIALS	OTHER	OVERH/PROFIT	TOTAL VALUE	AMT. ACCEPT
1	EXTRA WORK DUE TO UNFORESEEN GROUND CONDITIONS	1781.60	2000.00	1017.67	0.00	239.96	5039.23	3000.00
2	DELAY DUE TO ENGINEERS INSTRUCTION	2500.00	1457.00	2000.00	0.00	537.81	6494.81	0.00
3	DELAY DUE TO SUSPENSION OF SECTION 2	2500.00	25000.00	0.00	5000.00	1912.81	34412.81	26000.00
4	DELAY DUE LATE ISSUE OF DRAWINGS	1000.00	2000.00	0.00	0.00	1912.81	4912.81	2000.00
5	EXTRA COST DUE INSOLVENCY OF M/E SUBBIE	2500.00	3000.00	1500.00	0.00	2262.81	9262.81	3500.00
	All Claims to date	10281.60	33457.00	4517.67	5000.00	6866.22	60122.49	34500.00

APPENDIX 24: Pricing of resources employed on a Claim on a given day

CLAIM NO. 1 EXTRA WORK DUE TO UNFORESEEN GROUNC CONDITIONS

DATE: 23/ 1/84

LABOUR

RESOURCE	DESCRIPTION	UNIT	QUANTITY	UNIT COST	AMOUNT
23	JOHN SMITH -LABCURER	HR	8.00	4.16	33.26
25	HAROLD SPELMAN -GANGER	HR	8.00	5.90	47.20
43	DIESEL ROLLER DRIVER	HR	6.00	5.00	30.00
	Total LABOUR Prime Costs				110.46
	Add 5.00 % for Overheads/Profit				5.52
	Total for LABOUR				115.99

PLANT

RESOURCE	DESCRIPTION	UNIT	QUANTITY	UNIT COST	AMOUNT
46	DIESFL ROLLER	HR	6.00	10.00	60.00
11	JCB 3C EXCAVATOR	HR	8.00	8.84	70.69
7	PLATE CCMPACTOR	HR	8.00	1.92	15.38
5	LORRY -TIPPER 6 M3	HR	8.00	16.37	130.98
	Total PLANT Prime Costs				277.05
	Add 5.00 % for Cverheads/Profit				13.85
	Total for PLANT				290.90

MATERIALS

RESOURCE	DESCRIPTION	UNIT	QUANTITY	UNIT COST	AMOUNT
22	GRANULAR FILL	M3	10.00	8.42	84.20
27	SAND	KG	8.00	8.00	64.00
58	PORTLAND CEMENT TO BS12	TNNE	2.00	48.76	97.52
	Total MATERIALS Prime Costs				245.72
	Add 5.00 % for Overheads/Profit				12.29
	Total for MATERIALS				258.01

CLAIM SUMMARY

	PRIME COSTS	OVERH/PROFITS	TOTAL
LABOUR	110.46	5.52	115.99
PLANT	277.05	13.85	290.90
MATERIALS	245.72	12.29	258.01
OTHER	0.00	0.00	0.00
SUB CONTRACTOR	0.00	0.00	0.00
Total value of Claim	633.23	31.66	664.89

APPENDIX 25: A Sample of a Sub-contractors' Letting Margins Report

CONTRACT:CONSTRUCTION OF THE M999 MOTORWAY

SUBCONTRACTORS LETTING MARGINS

SUBCONTRACTOR	VALUE	S/C AMOUNT	GAIN	LOSS
Muckshifters Ltd.	50712.32	45641.09	5071.23	
Buckingham Roadworks Ltd.	70837.91	63754.12	7083.79	
T. H. Tamson & Sons Ltd.	110410.02	126971.53		16561.51
Brunner & Son LTD.	133900.00	120510.00	13390.00	
Safeways Demolitions Ltd.	80803.44	92923.96		12120.52
Micawber Painting Works Ltd.	79227.31	71304.58	7922.73	
Carl Bentle Construction Ltd.	97001.48	87301.33	9700.15	
Hopkins Asphalt Works Ltd.	145780.98	131202.88	14578.10	
Douglas Rowe Construction Ltd,	36550.11	32895.10	3655.01	
Sir Robert Willoughby Ltd.	205100.09	235865.12		30765.03
	1010323.66	1008369.70	61401.03 59447.07	59447.07
Overall Gain			1953.96	

APPENDIX 26: IMPLEMENTATION CONSIDERATIONS

CONSTRUCTION OF WORK PACKAGES

There is neither a standard criterion for breaking a project into Work Packages nor a standard system for coding them (171, 177). The software in this thesis allows the user to define his own methods of breakdown and coding systems. As an example, the following CESMM classification of civil engineering work can be used as Work Packages:

A General Items
B Site investigation
C Geotechnical and other special processes
D Demolition
E Earthworks
F In situ concrete
H Precast concrete
I Pipework-pipes
J Pipework-fittings and valves
K Pipework-manholes and pipework ancillaries
L Pipework-supports and protection, ancillaries to laying and excavation.
M Structural metalwork
N Miscellaneous metalwork
O Timber
P Piles
Q Piling ancillaries

R Roads and pavings

S Rail track

T Tunnels

U Brickwork, blockwork and masonry

V Painting

W Waterproofing

X Miscellaneous work

Y Sewer renovation and ancillary works

The code numbers that are used as centres for the collection of estimating data (e.g., quantities, units, build-ups) are also the centres for the collection of valuation data. Two main approaches to the design of codes for Work Packages are identifiable. The first approach is to relate the Work Package code to the codes for the estimating and valuations functions. Examples using CESMM codes are the use of E, E4, and E41 to cover 'Earthworks', 'General Excavation', and 'General Excavation of Topsoil', respectively. Where the estimating, valuations and Work Package codes are related in this manner algorithms can be designed to determine the parameters of Work Packages from the corresponding parameters of the bill items, and vice versa.
Even with civil engineering this approach is not without problems which arise from the fact that the coding system still allows the user some discretion

in the extension of codes. As such discretion is likely to be exercised differently from company to company or individual to individual, there can be no unique sets of relationships between the codes of estimating and valuations data and those of Work Packages. For example, 1.E411, E411, 2.E411 can refer to 'General excavations of topsoil for re-use, maximum depth not exceeding 0.25m' at 3 different locations. The same items could have been coded validly as E411, E411.1 and E411.2. Indeed, the possible coding combinations are infinite. It is, therefore, not feasible to design a alorithm to cover all the possibilities.

The second approach is to devise a coding system for Work Packages which has no direct relationship to bill codes. For example 'Earthworks' could be coded hierarchical as:-

10	Earthworks
10.1	Dredging
10.2	Excavation of cuttings
10.3	Excavation of foundations

PLUS VAL allows the user to construct his own Work Packages by requiring him to define them first and then specifying the Work Packages to which each bill item belongs. This information is then stored together with the other attributes of the bill items (e.g., description, unit, quantity).

However, PLUS VAL recognises that particular companies may prefer to link the coding systems and the breakdown of projects into Work Packages. The following customizing adjustments to PLUS VAL would be necessary:

* the module requiring the specification of the Work Packages of each bill items should be modified to eliminate the input to be rendered redundant;

* the modules which build up parameters of Work Packages from the corresponding parameters of the component bill items should be modified so that the build up is via the bill item codes

For the breakdown to be useful for feedback of data to estimating users must adhere to the same breakdown and coding systems for every job.

INTEGRITY OF DATA INPUT

In Chapter 13 the following were specified for PLUS VAL:

* minimum data input,
* error detection and prevention during input.

The use of integers as references of resources instead of alphanumerics (e.g., M22, L23) was as a result of consideration of the first requirement. To reduce the risk of incorrect input, e.g., typing 22 when the user intended 23, PLUS VAL allows the user to obtain details of the resource by typing 'VERIFY' after the resource number. As displays of such details can be time-wasting the System allows the user to turn this facility off. A second error detecting facility is available where the transaction being carried out implies the input of only numbers of specific types of resources. For instance, when inputting details of inventories of materials the number of a labour item is input an error message 'This is not a material item' appears on the VDU.

It has been recognised that the use of alphanumeric references may further reduce the risk of incorrect input. This facility has not been provided in full because of the lack of standardisation of such codes. However, hooks have been left for future customizing adjustments.

FEEDBACK OF SITE PRODUCTION DATA TO ESTIMATORS

The rationale behind feedback is that for the same operation the measurement of actual performance should not be far different from the standard. Where there are significant differences the possible reasons include:

* the two sets of data are not comparable because they refer to different operations or to the same basic operation executed under different circumstances.

* actual performance is different from the budgeted performance.

* unbalanced tenders

* incorrect actual performance data.

These reasons are discussed in detail in Chapter 5. The decision as which of them is the case in any particular situation involves some professional judgement and mental processes for which computers are not presently suited. Evaluation of cost should, therefore, be carried out external to the system. This requires that the person carrying outthe evaluation process understands the estimating processes used. Two levels of evaluation are identifiable. The first concerns operations which have been carried out so many times on a project that the project data alone can be the justification for the changing of corporate estimating data. The more usual position is that data on an operation from more than one project is needed for meaningful evaluation. This would require continual post-contract audits at head office. As head office staff are unlikely to be familiar with the detected circumstances under which the operations were carried out, there is a need for site management to make appropriate comments against operations with variances between standard and actual perfomances. For instance, an additional column for comments could be added to the right side of the report in Figure 5.5.

PURCHASE OF MATERIALS

Gobourne (160) identifies three heads of costs of materials:

* costs in quotations (estimator's costs),
* costs in purchase orders,
* actual costs to the contractor.

They are described in greater detail in Chapters 9 and 14. PLUS VAL recognises these costs by providing for two types of margins as can be seen from the menu in Figure 14.19:

* Margins on Orders,
* Margins on Deliveries.