An information system for estimating, targetting and planning in small building firms.

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ABSTRACT.

An Information System For Estimating, Targetting And Planning In Small Building Firms.

S. E. Westgate BSc(Hons)

This thesis outlines the basic problems relating to estimating, targetting and planning functions in small building firms and a possible solution.

It was found that information for these functions was rarely integrated and was derived from different sources. It was therefore suspect in terms of accuracy. Four case studies were undertaken and the firms were investigated and analysed in terms of their logical and physical organisation and management systems. Their basic problems were the lack of control of costs, slow feedback of information, low labour productivity and a shortage of staff to carry out the administration work.

A general model was derived from the four case studies and this was used to specify the problems in terms of detailed activities and data used. The general model was analysed to derive a prototype system which co-ordinated the data in the different functions by using production oriented, operations, each with a standard performance output.

Database management techniques were then used to structure the data effectively so that the prototype system could be implemented using a standard database package on a micro computer.

A standard database file of operations was built up for alterations, refurbishment and repair work.

A number of estimates were generated and compared to identical ones prepared by hand. All related planning and targetting information was then prepared. It was found that taking off of estimates took a little longer but once completed much relevant planning and targetting information could be generated and feedback obtained. This was all directly related to the estimate due to the integration of the functions. The management information generated allowed better control of costs and outputs with little administrative effort.

HYPOTHESIS.

Small building firms tend to produce estimates, targets and planning information from separate sources of data.
This information can be based on standard data and it should therefore be possible to produce an information system developed by data base management techniques which integrates the activities.

ACKNOWLEDGEMENTS.

I would like to thank my two research supervisors, Mr. Ray Oxley and Mr. Paul Barton who provided me with their time and experience which helped to bring this project to a successful conclusion.

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CHAPTER 1.

INTRODUCTION.

1.1. STRUCTURE OF THE BUILDING INDUSTRY AND THE ROLE OF THE SMALL FIRM.

In Great Britain the Construction Industry contributes aproximately 7 per cent of the total industrial output (£21 billion) and employs 6.5 per cent of the total workforce. (1.37 million.) (Manpower Research Group:1981)

The inherent characteristics of the Construction Industry give it a unique structure in comparison to other manufacturing industries. The industry is made up of a large number of production units (over 100,000) which vary considerably in size. The vast majority of firms employ less than than 25 employees and account for 40 per cent of the total number employed, whilst the single largest firm employs approximately 3 per cent of total employed. (See Figures 1 and 2.) (Manpower Research Group:1981, DOE:1984)

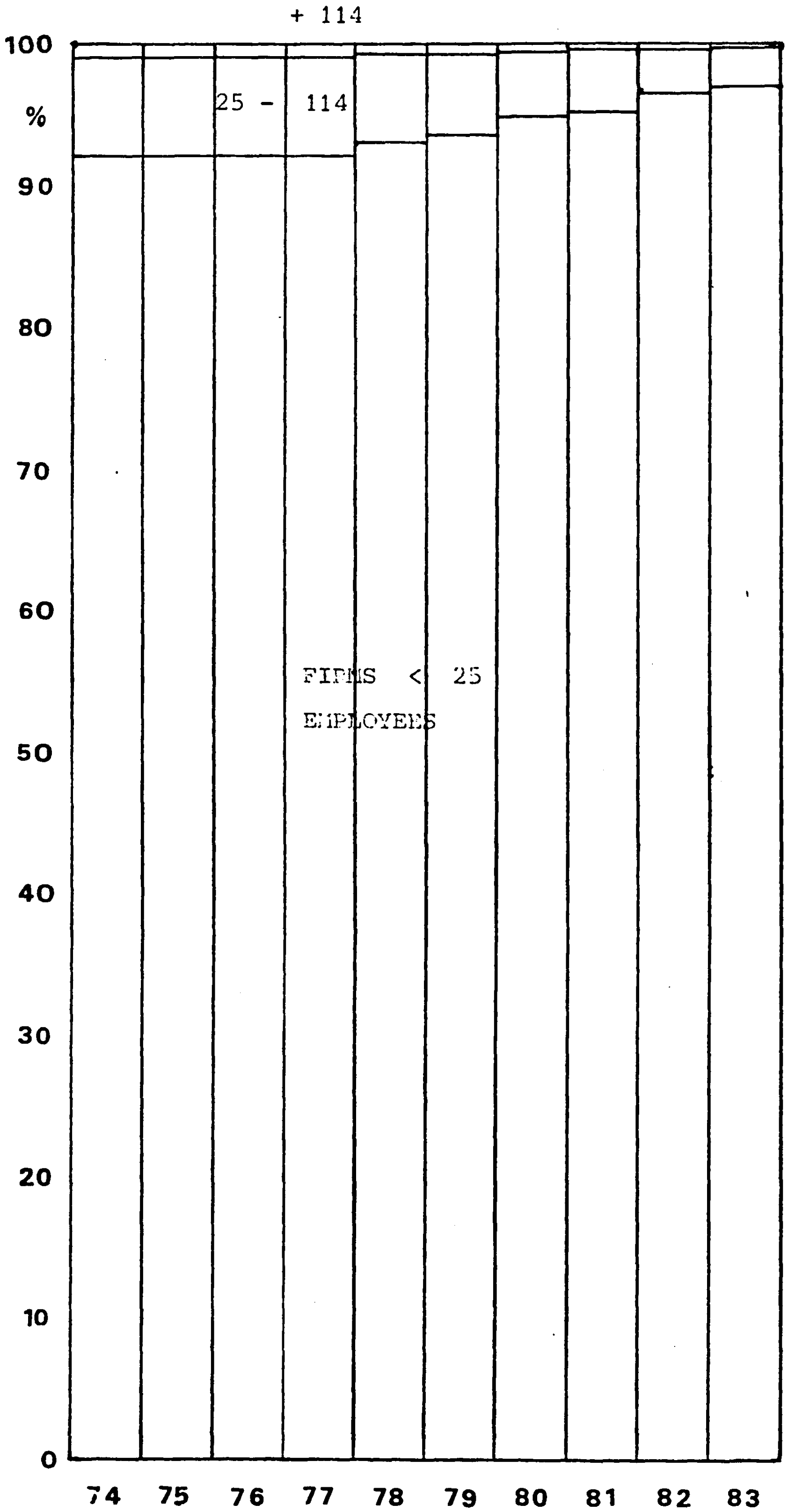


Figure 1. SIZE OF FIRMS. 1974—1983.

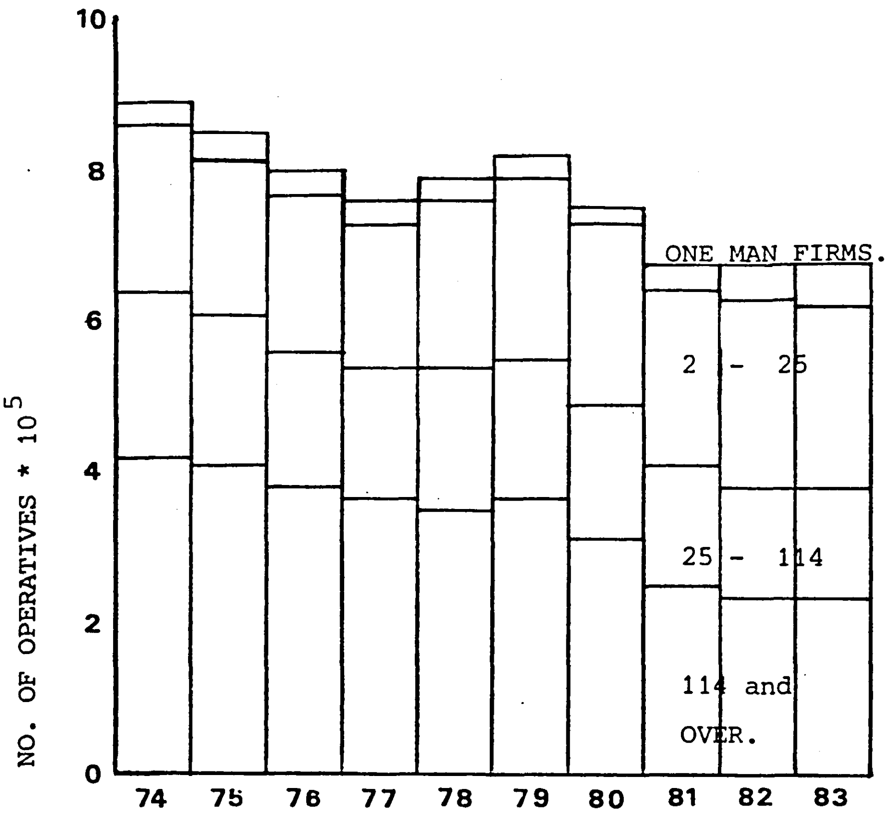


Figure 2 EMPLOYMENT OF OPERATIVES IN FIRMS

1974 - 1983.

Methods of construction vary from capital projects which are plant intensive to small repair and alteration contracts which are labour intensive.

A number of reports and studies have helped attempt to identify the characteristics of the construction industry and the firms within it. One such report concerned small firms in general (Bolton:1982) and this gave a standard statistical definition of a small firm, as one directly employing under two hundred employees and a small construction firm as one directly employing under twenty five employees. Construction firms were separated from the rest because of the structure of the industry.

Employment patterns have changed since the Bolton report was written. The number of employees directly employed has decreased whilst the proportion of labour-only sub-contractors has increased significantly since 1970. (Langford:1985) This fact was strongly emphasised by all the firms consulted during this research.

Economic factors have also changed since the early 1970's when the Bolton report was written. The small firms sector of the construction industry has changed. There has been a notable increase in the amount of repairs and maintenance and a decrease in new work carried out. (DOE:1984) As the amount of new work has decreased, the larger firms have had to take on more repair and maintenance contracts to compensate. This has meant that larger firms who re-sorted to repairs and maintenance have entered into the small firms economic market.

To use Bolton's statistical definition of small building firms seemed restrictive because of these recent changes. Other related papers have still relied on Bolton's statistical definition of a small firm but have also outlined the generic features that a small building firm should possess. (Grant:1983, Hillebrandt:1971, Norriss:1984, Fleming:1980)

Bolton stated three generic characteristics that any small firm should display;

i) A small market share in economic terms,

ii) Be managed by its owners,

iii) Have independance from outside control.

Hillebrandt stated that small firms were important to the construction industry due to;

i) The types of demand made on the industry,

ii) The geographical spread of the work,

iii) Ease of entry into the industry,

iv) Nature of the client,

v) Relations with operatives.

She also gave a profile for the general nature of a small building firms.

i) They took work on which was short in duration, and required little plant.

ii) No skills above that of craft were required and sometimes one operative could do the work.

iii) A considerable amount of their work consisted of repairs and maintenance.

iv) The majority of the work was within a twenty miles radius and little work was outside a radius of fifty miles from their base.

Norriss corroborated the majority of characteristics listed above and stated that the majority of work fell into two categories repairs/maintenance and extensions/alterations. He also stated that the majority of the work was carried out by the firm itself and not subcontracted out which does not hold true today as the swing towards using labour-only sub-contractors has increased. (Langford:1985)

Apart from the statistical studies carried out, if the people running the firm viewed the firm as small, it invariably was. (BTM:1982)

For the purpose of this research a small building firm must exhibit the three basic generic characteristics laid out by Bolton and the other characteristics outlined above. Reference must also be made to the number of employees in a firm, but the nature of the research into the systems used by building firms made the consideration of generic rather than statistical characteristics more important.

1.2. THE BASIC PROBLEMS RELATED TO ESTIMATING, TARGETTING AND PLANNING.

Although the majority of firms are small, most research has been directed towards the needs of large firms. (Gorn:1978)

A number of useful techniques in the field of estimating and production planning have been developed, but most small building firms are not aware of their existence or their application e.g. computer aided estimating and network analysis. (Colley:1985, DOE:1979, Day:1981, Barfield:1982)

Many small building firms have basic problems relating to their estimating, targetting and planning systems. They do not seem to have information in the correct format in order to make well informed management decisions. The fundamental reason for these problems lies not with the people who run the systems but the systems as a whole. (DOE:1971) Other studies stated that the faults were concerned with the separation between the estimating function and the production management functions. Information required for production management is not related to the estimate because the information structures are not co-ordinated. (BRS:1969) The estimate, if used correctly, can provide a basis for accurate feedback to monitor the firms productivity and profitability. A study by Braid, found that sixty five per cent of small builders did not know how to operate a feedback system and thirty five per cent said it was too expensive to operate in terms of cost or time. (Braid:1984) No accurate information was available to assess how many small builders directly related planning and targetting to estimates. A survey by Norriss indicated that only fifty five per cent had formal planning techniques and only thirteen per cent drew up bar charts. (Norriss:1984)

Due to the large number of contracts small firms undertake, their greatest problem was administration and paperwork. (Colley:1985, Norriss:1984) The extra work required for integrating estimating with production management would require the small builder to increase staff overheads, which would, in turn, make them less competitive and less profitable. The consequent pressure of time has led many of them not relating estimating to targetting and planning which has resulted in a lack of feedback and an inability to control costs effectively or ascertain the productivity of operatives on site.

Although identified fifteen years ago, these problems still hold true for small builders today. A tender is often produced from an estimate based on the estimators general experience. If the tender is accepted, the estimate is rarely used to produce planning and targetting information because the information is held in the wrong format.

These problems could be alleviated by structuring the data in such a way as to make it more meaningful for different functions. The solution put forward was to structure the information essential to both estimating and production in terms of the methods used during production. The basic requirement was to provide a flow of information based on site operations to provide feedback on productivity, progress and costs. (BRS:1969)

Further studies applicable to the construction industry were carried out after 1969. They identified the structure of contractors information systems and improved them by integrating estimating, planning and targetting which produced effective control procedures. However, the systems relied very much on paperwork, manual re-sorting and re-calculating to integrate the flow of information between the functions. (Cooper:1970, BAS:1968, DOE:1971,1972,1979, BRS:1969, BRS(Skoyles):1969)

More recent studies have detailed the practical requirements for implementing integrated estimating and management systems using computer technology. These have tended to reduce much of the administrative work involved and allowed builders to integrate a number of functions. (McCaffer and Sher, Norman:1985)

1.3. SYSTEMS ANALYSIS AND DATABASE MANAGEMENT TECHNIQUES.

Since the 1970's great improvements have been made in developing methodologies to analyse information systems and implement solutions using computer technology.

One such methodology is systems analysis which is now a well recognised tool for producing models of the current business system and using this as a basis for problem identification and solution. The modern methodologies produce specifications which detail the flow and storage of information, the functions which use the information and a detailed analysis of the data in the information flows and the processes that transform the data.

Database management techniques devised in the 1970's recognised that the most effective way of storing information for a number of separate functions was to structure the data so that it was independant of the application programs. (Deen:1977) Separate functions should be able to use the data base effectively, ensuring that data items need only be entered and stored once to reduce redundancy, duplication of effort and storage space.

Using these techniques it should be possible to produce an information system which is structured in such a way as to enable small building firms to input data once during estimating and then use this for other functions.

1.4. OBJECTIVES OF THIS RESEARCH.

The aim of the research was to analyse the requirements and develop an integrated system for estimating, targetting and planning in small building firms. This was broken down into a number of objectives which had to be carried out in order to achieve this aim. These objectives were;

i) To analyse a number of firms using structured systems analysis to describe their business enviroments and identify their basic problems. The analysis would provide a detailed graphical representation of how the firms operated and a descriptive account. The separate analyses would be used to identify any similarities or differences between the firms. (See Section 3.)

ii) To produce a general model which would act as a standard representation of small building firms' business systems. The general model would then be analysed in detail in an attempt to identify the data used and activities carried out within the business systems. This could then be used to provide a basis for problem identification and developing improvements. (See Section 4.)

iii) To co-ordinate the data used in the estimating, planning and targetting functions so that information was derived from a standard source. To produce a standard source of data containing information relevant to the needs of small building firms. (See Section 5.)

iv) To design and implement a system which enabled small building firms to set up estimates using standard data and subsequently use the estimate as a basis for producing related planning and targetting information. (See Sections 5 and 6.)

v) To assess how successful the integration of estimating, planning and targetting was, using the collaborating firms as a test bed for the system. (See Section 6.)

These objectives form the chapters of the thesis after a chapter which outlines the research methodologies in relation to the building industry.

CHAPTER 2.

METHODOLOGY.

The hypothesis for the research stated that it should be possible to set up an integrated estimating, targetting and planning information system based on standard data for small building firms.

To ensure that the overall research effort was relevant and of practical use to the industry, collaboration took place with a number of firms throughout the project.

2.1. METHOD OF COLLECTING INFORMATION.

The methods used to collect and collate information had to be suited to its nature, detail, source and intended use.

A literature search was carried out initially based on a number of major abstracts produced by The Chartered Institute Of Building, research establishments and references from bibliographies.

During the period of research the literature research was extended by reading a number of relevant periodicals such as 'Building Technology and Management', 'Construction Computing', 'Building' and 'Computing'.

Information collected from the collaborating firms was detailed in nature and had to be verified by them for its accuracy. Questionnaires were unsuitable as the information required could not have been collected or checked without great effort. (Burch and Strater:1974)

The most appropriate method for collecting information from the firms was by structured interviewing.

The success of these interviews was important as the information formed the basis of the analyses which described the firms management systems.

To reduce the time spent collecting information, a number of rules were followed.

i) Each interview was carefully planned so that both the interviewer and interviewee knew the topics of the discussion and the approximate interview duration.

ii) During the interview, specific points were raised which required objective responses.

iii) Brief notes were taken covering these points to form a record of the interview.

iv) At the end of each interview the details were summarised and checked for accuracy, after which they were written up and a copy sent to the interviewee for verification. (Gorden : 1975, Moser and Kalton :1971)

Informal discussions were also held with managers from other small firms who expressed an interest in the research.

The effectiveness and limitations of currently available software was also investigated. Software packages were investigated by requesting trade literature, viewing systems at demonstrations and at Interbuild and reading many articles explaining packages. (CICA:1984, Trimble:1984)

A number of lectures were attended in both the Department Of Building and Department Of Computer Services to provide tuition in relevant topics, such as systems analysis and database management techniques.

2.2. CASE STUDIES.

2.2.1. CHOICE OF FIRMS.

The selection of firms was difficult since there was insufficient time to study a statistically representative sample of small building firms in detail.

A number of small building firms were approached who appeared to possess the general characteristics mentioned above. (See Section 1.1.)

Subsequently four of them agreed to collaborate in the research. Two other firms also assisted during the progress of the research.

2.2.2. ANALYSIS OF THE FIRMS' BACKGROUND, ORGANISATION STRUCTURE AND MANAGEMENT SYSTEMS.

To gain a general understanding of each of the four firms an initial study to determine each firms' history and its present organisation and management structure was carried out. (See Section 3.1.)

An organisation chart was drawn showing the structure of each firm and the job titles for each member of staff.

The following additional background information was collected at this stage, to build up an overall understanding of each firm.

i) Present turnover and types of work done.

ii) Number and responsibilities of operatives and staff employed. Due to the rise in labour-only sub-contractors firms were asked for the total number of direct employees and fully employed labour-only sub-contractors.

iii) Types of work undertaken and geographical area of work.

iv) Methods of estimating used.

v) Contract management systems used.

vi) Future objectives and plans.

vii) General discussions related to problems within each firms management systems were initially held with staff of the firm. These determined common areas of interest and an outline of problems to be analysed.

This information formed the basis for subsequent research.

2.2.3. STRUCTURED ANALYSIS OF THE FIRMS' SYSTEMS.

Structured systems analysis developed by K. S. Mendes for the Exxon Corporation and Tom De Marco (Mendes:1980, De Marco:1980) was used to build logical models which described the firms management systems in terms of functions, information flows and stores. (See Section 3.3. and Appendix 1.)

The methodology enabled graphical models to be constructed of a current business system from which problems could be identified and solutions developed.

The analyses started from an abstract 'global view' of the whole system and its environment and proceeded by partitioning parts into more detailed parts. This provided a logical method of analysis which was easy to understand.

A business was defined as a set of major functions which existed to provide a service. (Mendes : 1980) Small building firms provide a general building and refurbishment service to clients.

Producing Information Flow Diagrams.

Sets of information flow diagrams were drawn as graphical networks, to represent the flow and storage of business information.

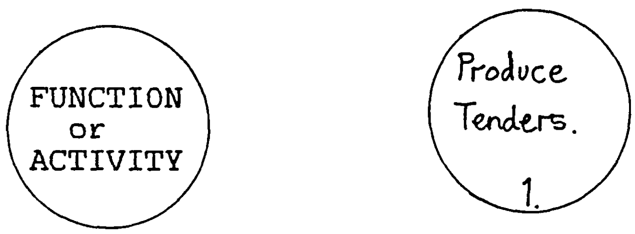
A 'context diagram' (global view) identified the top level information flow diagram showing a global view and illustrating how the business functions were related to the whole business enviroment. (See Figure 3.i. page 26.)

Each major function was separately broken down into activities which were related by logical links as information flows and stores. The identification of these activities and their links was important, because if they were related due to physical or personal attributes of the organisation or management systems, the analysis was incorrect. Figure 3.(ii) identifies the activities within the function, produce tenders, page 26.

As the analysis was partitioned into more detail it was restricted to the relevant areas of research which were specified in earlier discussions with the firms. All the parts of the analysis which were relevant to the research were grouped together in the 'domain of change'. (De Marco:1980) This restricted the extent of the project and ensured that the final analysis was detailed and relevant to the research.

Each set of diagrams was 'levelled', when they were partitioned into the level of detail required and all the diagrams interrelated logically. When completed the set of diagrams were said to be 'balanced'. (De Marco:1980)
The level of detail required was reached when the activities on the diagrams and the information flows and stores exhibited data attributes in sufficient detail for analysis, termed the 'bottom level'.
Below is a summary of rules and definitions used to build up a set of levelled information flow diagrams. (De Marco:1980)

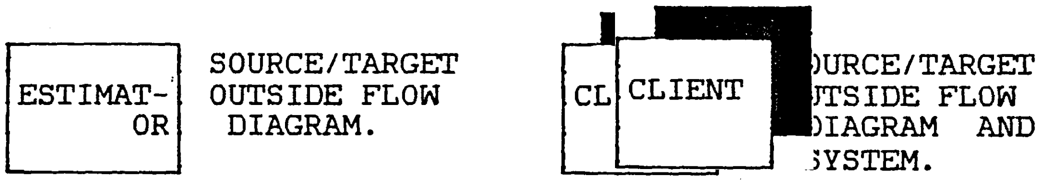
A business is made up of number of functions and activities linked together by information flows and stores.



A flow is the transfer of information or material between business functions, activities or processes.

An information store is a passive repository of information which could be automated or manual.

Sources or targets for information were categorised into those outside the business operation and therefore outside the scope of the analysis, e.g. the client; and those inside the business operation and within the analysis, e.g. the estimator.



Diagrams were balanced by making the information flows into each diagram, function and activity equivalent to the flows out.

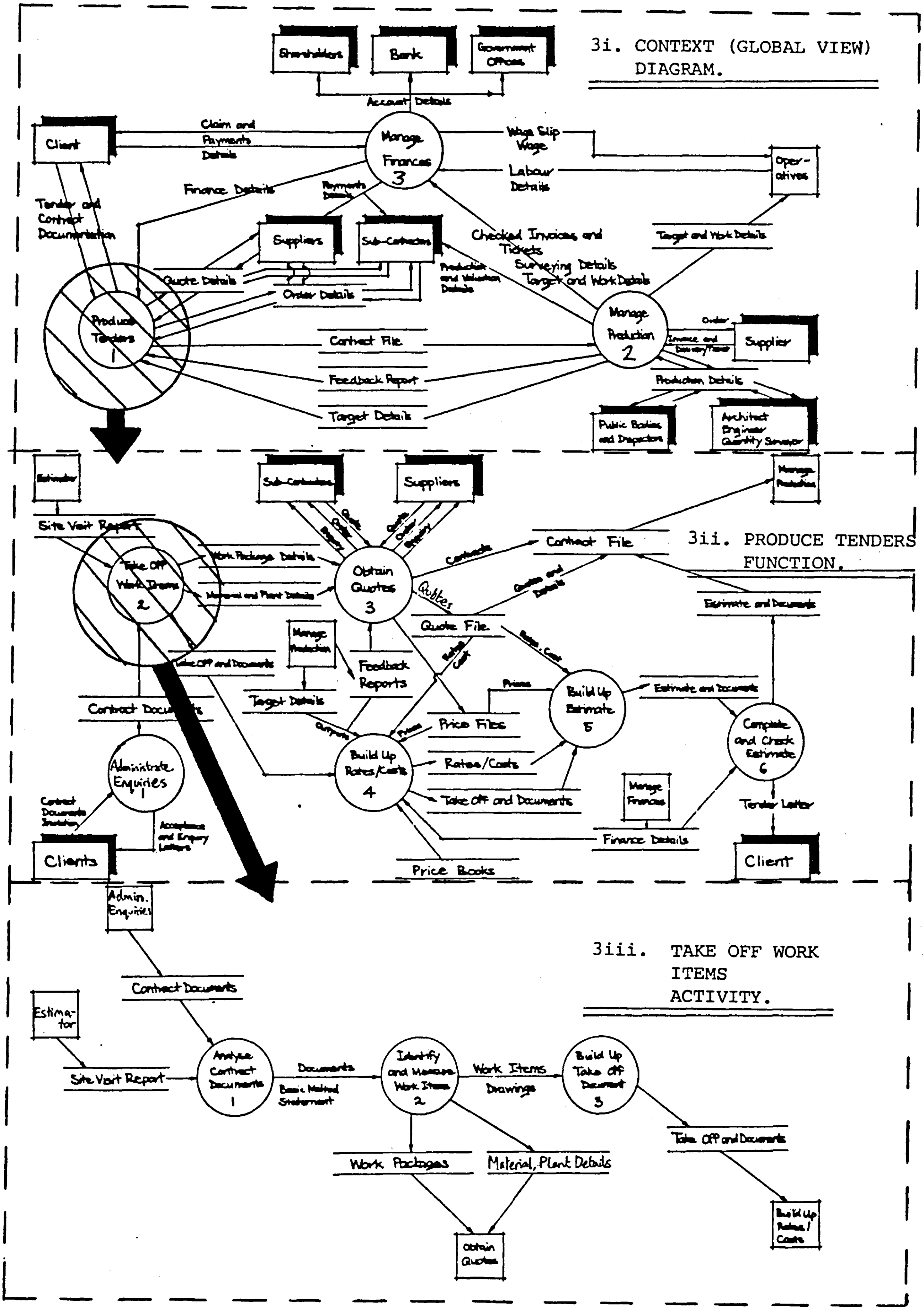


Figure 3. BALANCED SET OF INFORMATION FLOW DIAGRAMS.

Producing A Function Matrix.

A function matrix related the logical functions and activities to the physical organisation chart. (Mendes:1980) Figure 4 represents an example of a function matrix for a typical small building firm.

Major responsibilities were indicated by an "X" in the relevant cell of the matrix. For example, 'Taking Off' was a major responsibility for the estimator. Similarly, an "x" a minor responsibility for people performing the function. For example, 'Plan and Organise Work' was a minor responsibility for the estimator. (See Figure 4.)

RESPONSIBILITY FUNCTION	CON MAN DIR	EST QS. DIR	QS	FORE MAN	CLERK
BUILDING.	X	X			
MANAGE FINANCES	X	X			
General accountings.	x	x	x		X
PRODUCE TENDERS.	x	X			
Administrate enquiries.		X			
Take off work items.	x	X			
Obtain quotes.		X			
Build up rates/costs.	x	X	x		
Build up estimate.	x	X			
Complete and check estimate.		X			
MANAGE PRODUCTION	X	X	x		
Plan and organise work.	X	x	x	x	
Calculate incentives	X	x	X		
Manage labour.	X	x	x	x	
Manage sub-contractors.	X	x			
Manage material and plant supply.	X	x		x	
Administrate surveying.	X	x	X		

Figure 4. Typical Function Matrix Diagram.

Verification Of Case Studies.

Each case study was considered to be complete when the manager confirmed that the model represented a logical view of the firm. The whole model was explained to managers using 'walk throughs' which described how the model was structured, the logic behind partitioning the business into functions and related activities and how these were represented using flow diagrams. (De Marco:1980)

2.2.4. PRODUCING AN OVERVIEW OF THE ANALYSES.

To help describe and explain each analysis a short overview was written for each case study. This helped as different operating methods were used, which were not always apparent from the analysis. For example, the method of measuring and pricing quantities in the four collaborating firms were different, but they all used similar information.

The analyses were then used as a basis for identifying problems the firms had. (See Section 3.4.)

2.3. DEVELOPMENT OF A GENERAL MODEL.

A general model was developed from the four case studies which incorporated their similarities and any individual strengths. Any physical links in the case studies had to be eliminated to create a purely logical model of small building firms estimating, targetting and planning systems. This model was then used as a standard from which further work was to be developed. (See Section 4.)

2.3.1. STANDARDISING THE STRUCTURED ANALYSES.

A top down approach was used to standardise the case studies starting from the context diagram and working through the sets of information flow diagrams.

Names of functions, activities and information flows and stores were standardised using conceptually correct and physically relatable terms. (See Section 4.1.) This enhanced understanding and helped critical appraisal of the general model.

The rules for standardising the models, were as detailed in Section 2.2.4.

2.3.2. BUILDING UP DETAILED INFORMATION FLOW DIAGRAMS.

Detailed information flow diagrams were built up for activities within the domain of change which gave a clear indication of the information used and activities performed. (See Section 2.2.4.)

2.3.3. DATA ANALYSIS.

The information flow diagrams gave little detail of the data contents within the information flows and stores, or the purpose of the activities. A data analysis was therefore carried out which defined the data items and activities. These were set out in a data dictionary for use as a reference manual when inspecting the information flow diagrams. (See Section 4.4.)

The data dictionary was divided into two parts, one defining the data used, the other defining the activities performed on the data.

The rules used for developing a data dictionary were as follows; (De Marco:1980)

i) Definitions should be recognised by name.

ii) Data should not be repeated in the dictionary, ie 'no redundancy'.

iii) Definitions should be simple and unambiguous. 'Structured english' was used which meant writing statements as simply as possible to avoid ambiguity and verbosity to ensure clarity.

iv) In order to structure definitions of information flows the following convention was used-

= means EQUIVALENT TO

+ means AND

[] means SELECT ONE OF THE OPTIONS IN THE BRACKET

* means ITERATIONS OF THE BRACKET.

() means THE BRACKET IS OPTIONAL.

KEY means all the data items within the data group were identified through the key field. (Deen:1977)

For example the data dictionary for a part of Figure 3(iii) would be;

(Flow)SITE VISIT REPORT = Contract name + address KEY
+ Contract Details
+ Site Details
+ Ground Conditions.
+ Services and Local Authority Details
+ Availablity of labour

+ Details of location, adjacent buildings, suppliers, sub-contractors.

(Activity) Identify and measure work items = Group similar work items together and measure quantity off drawings. Work out the the material and plant resources required.

2.3.4. ANALYSING THE PROBLEMS.

The general model and data analysis were used as the basis for designing the new system. Problems and ideas were critically analysed to develop them into their constituent information flows, stores and activities. (See Section 4.5.)

2.4. DEVELOPMENT OF A NEW SYSTEM MODEL.

Proposals to solve the problems were based on ideas suggested in projects in which the problems of data co-ordination, computer aided estimating and related functions were studied. (BRS:1969, DOE:1971, McCaffer:1980, Harrison:1982) (See Section 5.1.)

An integrated approach was adopted, whereby information created during estimating could be effectively used for production management and relevant feedback obtained. The proposals suggested were assessed in the context of the general model. (See Section 5.2.)

A new system model was built which incorporated the proposals. (See Section 5.3.) A detailed specification for the system was built up which included a balanced set of information flow diagrams with a data dictionary defining new terms. (See Section 5.4.)

The new system model was analysed to ascertain whether the analysed problems could be overcome by altering information flows, stores or activities. Careful consideration was given to the implications for firms using the new system, especially if their present systems were radically altered in any way. The important features to identify were the new links which had to be created between the firms present systems and the new system. If any were impractical to implement then other proposals were suggested. (See Section 5.5.) The new system model represented an overview of the proposed integrated system for estimating, targetting and planning in terms of information.

A standard database package for a micro computer was used for testing and implementing the new system.

2.4.1. DATABASE MANAGEMENT TECHNIQUES.

The advantage of using a database was that all the data for management systems was stored in a central repository in such a way that access and storage of data was efficient and effective for all users. (Deen:1977)

A database can be defined as "a collection of interrelated data stored together with controlled redundancy to serve one or more applications in an optimal fashion." (Martin : 1976)

A database is made up of entities which hold records of 'items' or 'things'. For example the entities of a database for estimates may be operation details and estimate details. Each entity can be defined in terms of its data attributes. The data attributes of an operation may include a code, description, unit of measure and unit rate. The estimate attributes maybe item code, description, quantity, rate and output.

The simplest structure is a relational database which is made up as a set of two dimensional tables, each table being called a 'relation'. A relation is built from logically related attibutes. Each relation must have one or more 'key fields' which identifies and provides links between relations. For example in the estimate database, operations could be keyed on code.

To structure the data logically the relations had to be 'normalised' which reduces them to their simplest form, thus producing the most efficient structure for the data storage, creating independance. (Deen:1977, Lancashire:1985)

(See Section 5.6. for full example.)

From the initial tables of data attributes, all repeating groups of attributes are removed to separate tables with the key field as a link between them, to produce the 'first normal form.'

The relations are then checked to determine if any of the attributes have a 'partial dependence' on the key fields. Partial dependencies must be removed by amending the key fields and creating new relations, so that each attribute totally depends on the key. If so, it is in the 'second normal form.'

The relations are then checked to determine whether there are any 'transitive dependencies' between the attributes in each relation. These are then removed to form new relations,

so that each attribute is totally dependant on the key and independant from the rest of the attributes, producing the 'third normal form.'
The relations are then analysed to see whether they can be simplified in structure to make their implementation simpler.
When an initial data structure has been designed and the attributes given descriptions, code structures must be established. This is important as the codes describe the relationships between the relations. (Lewis:1983)

2.4.2. DATABASE OPERATING DESIGN.

The new system model was the basis for the database design which formed the core of the proposed system.
The data attributes to be included were taken from the data dictionary for the new system model. The attributes were then normalised to produce a logical data structure in the form of entity types (relations, tables) with keys and attributes. (See Section 5.7.)
The new system model identified all data inputs, outputs and data structures. From this information the format of inputs and outputs were designed which allowed the user to enter and receive data from the database. These were designed from user and data requirements identifiable from the model.
To process the data, procedural programmes had to be written which processed, sorted or indexed the data.

2.5. METHOD OF IMPLEMENTATION.

An outline plan for implementing the new system was formulated. Rather than attempting to implement the whole system as one, parts of the design were identified which could be implemented separately as modules. The procedural programs were written for the module and tested before further modules were developed to ensure that when complete the whole system would work. (See Section 6.)

On completion all the modules were tested using typical estimates. Any faults encountered at this stage were carefully investigated to check that they did not occur elsewhere in the system. After remedying the faults the system was ready for live testing and evaluation.

The criteria against which the system was evaluated were established from the problems stated and discussed with the collaborating firms whilst developing the case studies. The problems discussed were those directly attributable to the firms manual methods of estimating, targetting and planning. (See Sections 6.5. and 6.6.)

CHAPTER 3.

OVERVIEW OF CASE STUDIES.

3.1. INITIAL STUDY.

A total of four firms were investigated in detail. They were located in South Yorkshire and North Derbyshire. A summary of the general background information collected is outlined below.

Only one firm could be classified as a small building firm by numbers of direct and labour-only subcontract operatives employed. However, they all exhibited the three main generic characteristics required of a small firm; independant of outside control; small proportion of overall market and managed by their owners. (See Section 1.1.)

The majority of work for three of the firms was based on alterations, refurbishment and repairs, which was mainly based on specification and drawing contracts. They all had a large number of small contracts to fulfill, which caused problems in estimating and controlling due to the large amount of information which had to be handled for all the contracts.

The contracts were usually within fifty miles and most contracts were valued at less than £100,000.

Firm A could not be classified as a small firm due to its high number of directly employed employees. However, due to the recession they carried out a large amount of work based on specification and drawings normally associated with the small firms sector.

Firm B had a large number of operatives due to undertaking a considerable amount of very labour intensive brickwork pointing work.

3.2. ORGANISATION AND MANAGEMENT STRUCTURE.

(See Appendix 1. for the detailed information.)

An analysis of each firm's organisation chart and function matrix, showed that the organisation and management structure differed.

The only common attribute appeared to be that as a firm got bigger, the structure became more departmentalised and each person's role in the firm more specific. Such specialisation was not possible in firms B and D because of the lack of staff. Consequently, managers tended to get involved in carrying out all functions from tendering through to settling final accounts. The personal responsibilities of staff varied between firms and was related to their professional skills. For all the building firms studied, the majority of staff were involved with the management and control of work on site.

A summary of the initial information collected from the firms is shown in Figures 5 and 6.

Number of Operatives	60	68	20	40
Number of Staff	12	4	5	7
Sub Contracted Trades	Plumbing Electrics Decorating Roofing (Brickwork) (Carpentry) (Scaffold)	Plumbing Electrics Decorating Roofing Plastering	Plumbing Electrics Decorating Roofing	Plumbing Electrics Decorating Roofing Plastering
Turnover £ million	2	0.9	0.6	0.8
% Turnover From Specification and Drawing Contracts	80	90	80	70
Source Of Outputs For Estimating	General experience built up over a number of years;			
		Analysis Of Job Costing Information	Price books	Price books
Extent In Use Of Bonus Scheme	Very few jobs.	Most jobs.	Most jobs.	Not at all
How Were Jobs Planned.	Informal techniques were used to plan the majority of jobs, but bar charts were used if;			
	Value was > £50,000	Large or complex jobs	Large jobs	If the client requested one
How Were Construction Methods Determined.	Contracts managers and foremen would discuss the most effective methods.			
How Often Were Costs Controlled And To What Extent.	Monthly for all jobs.	Monthly for all jobs.	Monthly for all jobs, some weekly.	On Completion of contracts costs were reconciled.

FIGURE 5. SUMMARY OF INITIAL STUDY OF FIRMS ORGANISATION AND MANAGEMENT SYSTEMS.

FIRM / METHODS USED	A	B	C	D
What method was used to measure quantities for take offs; SMM/Operations.	SMM and operations	Operations.	SMM	Operations
How were items priced.	Lump sum and Unit rate.	Lump sum and Unit Rate.	Unit rates.	Lump sum and Unit Rate.
How were estimate margins included For - Large jobs	Gross	Net	Net	Net
- Small jobs	Gross	Gross	Gross	Gross
What formal Planning Techniques Were Used.	Simple bar charts were used by all the firms, nothing else.			
How Was Feedback Obtained From Site About Labour Costs.	Little Accurate Information was available.	From analysing incentive scheme sheets.	From analysing incentive scheme sheets.	No accurate information was available.
How Were Incentive Scheme Figures Calculated.	Related to estimate labour costs whereever possible.	Related to estimate and work study figures sometimes.	Always calculated from labour costs in estimate.	Not done.
What Proportion Of Savings Were Paid Back As A Bonus To Operatives.	All.	All.	All.	

FIGURE 6. SUMMARY OF METHODS USED.

3.3. STRUCTURED ANALYSIS OF THE FIRMS' MAJOR FUNCTIONS.

The global view of the information flows and stores were similar. Three firms, B,C and D, performed similar major functions, produce tenders, manage production and manage finances.

Firm A merged the production of tenders and manage production. Jobs were managed by giving contracts' managers responsibility from the tender stage through to the final account. They saw this as one large logical function.

However, it was still possible to identify similar activities carried out in all the firms. It was only when these functions were analysed in more detail that the following similarities and differences became apparent.

3.3.1. PRODUCE TENDERS.

All the firms' tendering activities and information flows were similar. Differences between firms were mainly concerned with the method of measuring the quantity of work from the drawings and the method of pricing the work. This was not readily apparent from the information flow diagrams, since the activities, information flows and stores were similar. Three firms 'took off' quantities in terms of operations, which were directly related to the method of construction. When estimates were being prepared, all labour, plant and material resources required for items were measured and listed. Items were usually a conglomerate of logically related construction operations identified by the estimator.

The first operation in Figure 7 includes taking out the old floor, lay hardcore, sand blinding, DPM, shuttering, fixing reinforcement, placing concrete and a topping screed.
Estimates were built up from the substructure and worked through to the roof followed by finishings. Preliminaries and overheads and profit were then added.
As the estimate was being built up, planning information for the contract was written on it by the estimator. This can be seen on firm A's sample estimate where there are notes relating to the construction process. Method statements were rarely produced as separate written documents, but as notes added to the estimate.
Figure 7. shows a typical operation as taken off by one of the firms. The firm produced hand written documents.

NAME AND ADDRESS OF JOB AND CLIENT.

Compress up extg conc apron to required depth for new fdns. Supply & lay limestone h/c, sand blind, dpm, & conc flr & thickened out toe, & lay 1.5" sand cement screed.

5 X 5.6 = 28m.sq
1.8x1.3 = 2.5m.sq   Area = 30.5 m.sq.

Compressor and lorry.			£
Conc 30.5 × .250 = 7.6 32m.cu 18.5 × .75 .25 = 3.5			£
2000 gauge polythene 35m.sq.			£
Limestone and sand			£
Shuttering			£
Reinf. 17 × .900 = 15.3 + laps 17 × .600 = 10.2 = 25.5 - 30.			£
Labour	Set out		
	Compress up take out B & L	1 dy	£
	Lay h/c, sand, poly, rein, B & L	1 dy	£
	Erect shutter J & A	7 hr	£
	Conc 2B 2C	6 hr	£
	Strip shutter and rub up. B	3 hr	£
Screed 30.5m.sq.		5	£
			£ TOTAL
			£TOTAL + MARK UP

Figure 7. TAKE OFF AND ESTIMATE SHEET FIRM D.
(Copied from hand written documents.)

Items which required quotes from suppliers or sub contractors were built up and sent off to a number of firms prior to taking off quantities. The most competitive quote was accepted after allowing for factors such as delivery costs or delays. If quotes were not received on time a covering figure was entered.

In pricing the work, four methods were used. Each firm used at least two of the following methods:-

i) Price each work item on a lump sum basis.

eg Fix new window, £40.

ii) Price each item by calculating the amount of labour, plant and materials. e.g. Fix new window,

Labour 3 hr £3/hr	= £ 9
Plant-temporary scaffold	= £ 2
Material-new window	= £29

iii) Apply a 'unit rate' to each item. eg.Hand dig trench

Size 1.3m × 1m × 60m. = 7.8 m.cube
Labour cost = £10.20 per m.cube

Cost = 7.8 * £10.20 = £79.56

iv) Build up an all-in rate elementally from individual rates for labour, plant and material.

For example, dig trench as above with machine.

Trench volume = 7.8 m.cube

Plant- JCB Digs at 2.6 m.cube per hr. Cost £10 per hour hire

Plant Cost = 7.8X2.6X10 = £30

Labour - Driver Rate £4 per hour. Duration 3 hr.
-Banksman Rate £3 per hour. Duration 3 hr.
Labour Cost = 4X3 = £12
= 3X3 = £ 9

Material-Timber shore
- Quantity = 10m
- Rate £3 per m.
Material Cost = £30

TOTAL COST £81

Material costs were calculated from the most upto date prices. Material prices for materials such as bricks and cement were known by the estimator, as they were needed on virtually every contract. For more specific items such as door furniture, the estimator telephoned the supplier for an upto date cost. The estimator had to do this for many items which was time consuming.

Labour outputs were calculated from the estimators previous experience and his knowledge of construction. Price books were sometimes used as a reference to back up the estimator's experience.

Three firms kept no standard records of labour outputs achieved, as no accurate feedback from sites was available. Firm B undertook a considerable amount of repetitive maintenance work and operated a bonus scheme in conjunction with the work. Over a period of time they built up a file of labour outputs which was used for estimating. They also had a file of work study outputs for general construction obtained from another source.

Feedback was obtained from target sheets but this was hard to analyse as targets were presented in a different form to the original estimate as the operations in the estimate were not the same as on the target sheets.

Two firms managed to extract information for targetting from the estimate but both found it very time consuming.

The estimate provided information for planning, as no formal method statement was normally produced. It was only used as such during the tendering process. Forward planning of contracts was intuitive and based on experience and estimates were rarely used as a source of durations for items. Simple bar charts were drawn up from experience, if requested by the client.

All the firms saw the possibility of using the estimate as the basis for production management but with the proviso that it must be effective in terms of saved costs or time.

When pricing small works and jobbing type contracts, all the firms included the overheads and margin in the labour rate as this saved administrative work and guaranteed a return on the estimated labour content.

For larger contracts three firms priced the work net and applied a percentage margin to the estimate while one priced it gross.

3.3.2. MANAGE PRODUCTION.

Plan And Organise The Work.

All the firms planned their work using similar methods. Bar charts were used if the work involved was sufficiently complex and needed the co-ordination of a number of trades and sub-contractors. Durations were related to the contract managers experience of how long it should take to carry out. Two firms stated that they always drew up a bar chart for large contracts, which had a value of over £50,000 or were complex in nature. The day to day planning of contracts was similar for all the firms. Each firm had a manager who was in charge of a number of projects. During the day these projects were visited and problems solved with the operatives or foreman on site. Much of the planning was intuitive and based on experience and covered only a few weeks. As such, the manager based his planning on his own interpretation of what the contracts required from inspection of the contract drawings and his experience in co-ordinating a number of operations and contracts.

Calculate Incentives.

Incentive schemes were used regularly by only two firms, who claimed that they were successful in cutting costs.

Firm B based its scheme on work study data for repetitive maintenance operations and bill rates for 'one off' contracts.

Firm C's scheme was based on target hours worked out from the estimate. If there was sufficient work to keep all operatives fully employed, a target was calculated for every item on each contract. However, the estimate was based on Standard Method Of Measurement type items and the collation of targets was very time consuming. (SMM6:1979)

Occasionally, Firm A worked out targets for contracts from the estimate (See Figure 8.) and gave these to operatives on a weekly updated bar chart and target sheet.

CONTRACT DATE.	QUANTITY	HRS	TOTAL
Attend to surface of hardcore, blind and level. Ensure no loss of concrete.	1250m.sq.	.11	137.5
Concrete bed 225 thick, fine tamp finish to falls. Include all formwork and joints.	1250m.sq.	.70	875.0
A252 mesh fabric reinforcement	2500m.sq.	0.08	200.0
			1212.5

FIGURE 8. TARGETTING CALCULATIONS.

Although considered useful by firm A's managing director, targets were too time consuming to prepare and were rarely used.

When the incentive was given in terms of hours, all the firms paid the operative all the time saved back as a bonus. This was calculated by multiplying the time saved by the basic rate. The final bonus payment was either the 'Guaranteed Minimum Bonus' if the bonus earned was less than this, or the earned bonus if it was greater.

The savings to the firm resulted from reduced preliminaries, higher productivity and savings from paying the basic rate for the labour hours saved, rather than the all-in-rate.

Firms A and D saw the advantages of using an incentive scheme but had doubts about implementing one, due to the amount of administration and control necessary.

Manage Material and Plant Supply.

Control of material and plant was similar for all the firms. When required on site, materials quantities were 'taken-off' and plant requirements ascertained and then checked against the estimate. Invoices were checked against delivery tickets and quotes before being paid.

Manage Labour.

Time and target sheets were checked by the contracts' manager to see that the hours booked down for jobs were factual and any claims for daywork were substantiated. Any disputes were settled before the sheets were passed onto accounts.

3.3.3. MANAGE FINANCES.

Finance functions were similar for the firms. In each case they knew the volume of work required to complete in a year to cover overheads and kept records of their profitability for each contract.

All the firms used a standard accounting system to run their finances, accounts and wages. One firm used a computer for its accounting and payroll procedures, the others operated manual systems.

All firms reconciled contract costs at the final accounts stage and three firms managed reconciliations at monthly intervals. To obtain further detailed information was impossible due to the amount of administrative work required and by the time it was produced it was of little management use other than for future contracts.

3.4. ASSOCIATED PROBLEMS.

During the studies, discussions were held with the firms to establish their opinions related to the problems that beset their management systems and possible solutions.

Due to the shortage of work, tendering was very competitive and to win a sufficient workload meant tendering for a considerable volume of work to increase the chance of winning tenders. All the firms were looking for ways to increase their productivity and efficiency on site and in the office as a way of improving their competitiveness and margins.

See Figure 6. for a summary of the firms problems, page 38.

3.4.1. PRODUCE TENDERS.

Accuracy and consistency of estimates could be improved by using accurate standard output data to estimate labour costs and obtaining reliable feedback information from site to keep a check on outputs achieved on site.

The time and effort was involved in producing estimates, particularly when contracts were based on drawings and specification requiring quantities to be 'taken-off' and calculated before the estimate could be produced. This problem was becoming acute as the firms tendered for more work in an attempt to win more contracts. The time taken in producing more accurate tenders could only be justified if the information was of use during contract management.

Updating of material costs was time consuming and costly due to the number of materials required and the diversity of suppliers.

Firm D had a problem due to having more than one estimator. Each estimator measured work and priced it according to his own personal methods. It was thought by all the firms that tender values varied because estimators were not using standard information.

The basic requirement was to estimate in greater detail and increased accuracy in terms of outputs and the build up of costs. However, they were only willing to take more time estimating if it produced better estimates and it provided them with readily available production management information.

3.4.2. MANAGE PRODUCTION.

The firms felt that although the estimate held much useful management information, most of it was difficult to extract because it was in the wrong format or structure.

One problem of planning the work was that little planning information was produced.

Other problems discussed concerned difficulties in co-ordinating all the resources required for a large number of small contracts.

There was a general feeling that productivity of operatives on site was low. It was felt that it could be improved by paying more attention to motivation.

Labour costs and productivity were largely uncontrolled and reliable feedback information unobtainable.

A major problem for all the firms was lack of sufficient staff to administrate control systems.

3.4.3. MANAGE FINANCES.

Three firms monitored contract costs on a monthly basis while the other calculated the profit obtained after the final account had been produced. No firm managed to control site costs down to sections of the work or trades. This would have required a considerable amount of extra work which the firms did not think worth while due to the extra costs involved.

All the firms thought that cost control was very useful providing it could be produced quickly enough to be used during production. The systems gave historical cost information which was only useful to control future similar projects.

Plant, material and sub-contractors costs were controlled by company invoices with delivery notes and quotes.

Direct labour costs were more difficult to control and this created a serious problem for the firms.

3.5. CONCLUSIONS.

An analysis of the organisation and management structures indicated that the firms possessed different physical characteristics, seemingly due to the attributes and attitudes of their staff and types of work undertaken. However, it was possible to identify many similarities when viewed in a more logical way using structured systems analysis.

At the most abstract level, each firm carried out similar functions and the high level information flows were similar. As each case study was analysed in more detail, the logical commonalities were still present. The activities which built up to form functions, information flows and stores were similar.

There were differences in some of the models caused mainly by trying to incorporate physical links into them. These were included to make the analytical case studies easier to understand and verify for all concerned. The differences in methods in carrying out activities were not apparent from the case sudies. For example, during pricing the estimate, although the method may differ, the information required by each firm was similar. Whether pricing an estimate using unit rates or building up all-in rates, they still used the same information; outputs, labour, plant, material and subcontract costs; preliminaries, overheads and margins required.

Obvious differences existed when a particular activity was not carried out by a firm, for example, Firm D did not calculate incentives.

However, there was sufficient evidence to suggest that a general model could be derived from the four individual case studies which would incorporate any of their similarities or inherent strengths.

CHAPTER 4.

DEVELOPMENT OF A GENERAL MODEL FROM THE CASE STUDIES.

4.1. STANDARDISING THE INFORMATION FLOW DIAGRAMS.

A general model was built up to integrate the four case studies into one standard model.

The information flow diagrams were standardised using the methodology described in Section 2.3.1.

One problem encountered in drawing the standard flow diagrams was that some activities and flows were present in some firms but not in others. For example, 'calculate incentives' was present in firms A, B and C but not D. These activities or flows were included in the general model for completeness as to have rectified such mistakes later would have been difficult due to the model's complex nature.

Slight differences occurred between firms' information flow diagrams when they carried out activities to different levels of detail. One example occurred when comparing the production of tenders function for firms B and C. For some small tenders, firm B priced items in the estimate using lump sum totals based on experience, while firm C produced all tenders in great detail, from a bill of quantities based on the Standard Method Of Measurement.

It was not possible to show whether the information store or flow was on a formal or informal basis on the information flow diagram. For firm B's incentive scheme, the method of calculating and giving operatives targets depended on the type of contract and the work involved. It ranged from a rough mental approximation and informal message, to a detailed analysis and formal target given to the operative in the form of a target sheet. In these cases the most complex case was taken for inclusion in the general model.

4.2. IDENTIFYING THE GENERAL MODELS' BOUNDARY.

Large parts of the model were not analysed as the research was restricted to the estimating, targetting and planning systems.

The domain of change and its relationships with the rest of the diagrams identified the limits of the proposed system and therefore the information flow diagrams required in more detail. (See Section 2.2.3.)

4.3. DESCRIPTION OF THE GENERAL MODEL.

The model consisted of a context diagram (See Figure 9.0.) which identified the three basic functions. Information flow diagrams were drawn for each function. The relevant activities within the 'produce tenders' and 'manage production' functions were then partitioned into greater detail to identify the data contents within the information flows and stores. (See Section 2.3.2.)

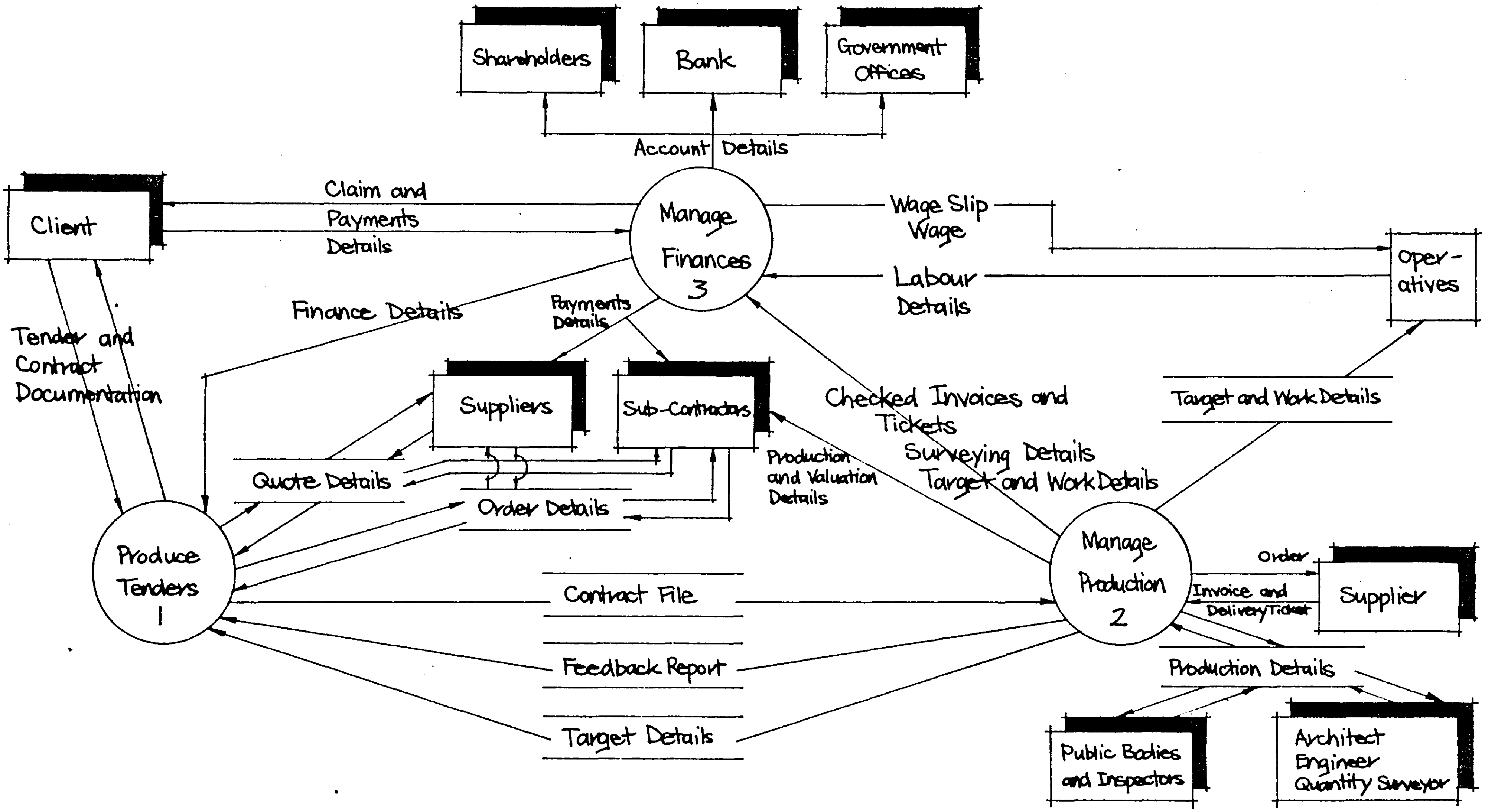


Figure 9.0. CONTEXT DIAGRAM FOR GENERAL MODEL.

4.4. DATA ANALYSIS OF THE GENERAL MODEL.

4.4.1. BUILDING A DATA DICTIONARY.

A data dictionary was built up to identify and define all the terms used in the information flow diagrams. (See Section 2.3.3.)

DATA DICTIONARY FOR THE GENERAL MODEL.

FUNCTION 1.0. PRODUCTION OF TENDERS. See Figure 9.1.

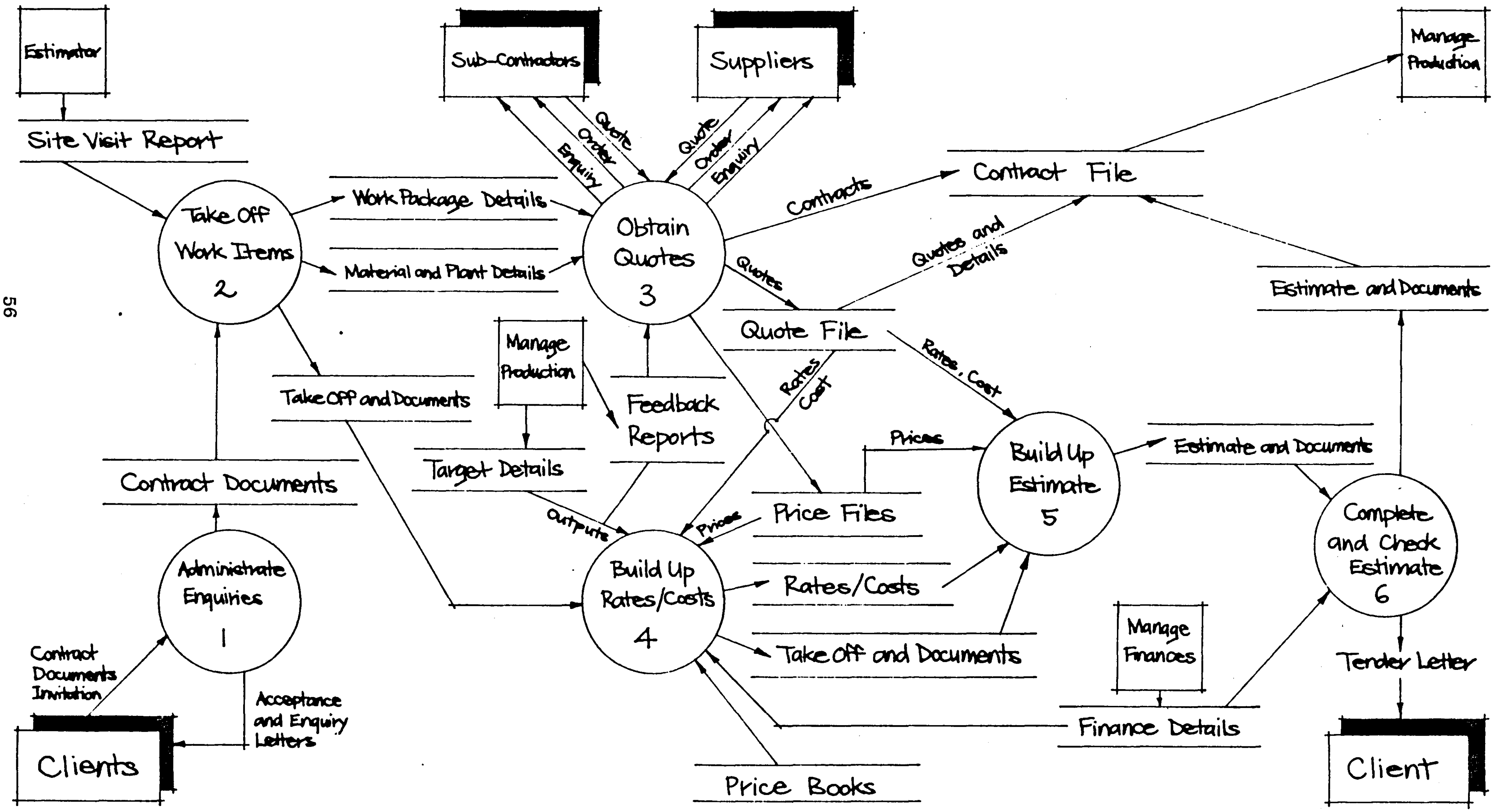


Figure 9.1.0. PRODUCE TENDERS FUNCTION.

ACTIVITY 1.2. TAKE OFF WORK ITEMS. See Figure 9.1.2.

INFORMATION FLOWS.

CONTRACT DOCUMENTS = Contract Code Number KEY
+ Contract Name + Address KEY
+ Client name + address + telephone number
+ Clients Consultants Details.
+ Contract start and finish date.
+ Specification
+ Drawings
+ Invitation to tender letter
+ Contract

SITE VISIT REPORT = Contract name + address KEY
+ Contract Details
+ Site Details
+ Ground Conditions.
+ Services and Local Authority Details
+ Availablity of labour
+ Details of location, adjacent buildings, suppliers, sub-contractors.

BASIC METHOD STATEMENT = Overall sequence and logic for carrying out operations.
+ *Size and structure of trade gangs*
+ *Work to be subcontracted out.*
+ *Basic plant to be used.*
+ *Possible Material + Plant suppliers to be used.*

WORK ITEMS = Description KEY

+ Quantity

+ Unit

WORK PACKAGES = Package Name KEY
To Sub
Contractors. + *Work Items*

+ Drawings + Specification

+ Contract.

MATERIAL AND PLANT ITEMS = Description KEY

+ Specification

+ Quantity + (Duration)

+ Delivery requirements

TAKE OFF = Contract code + name + address + client. KEY

+ *Work items*

+ *Work packages*

ACTIVITIES.

ACTIVITY 1.2.1. ANALYSE CONTRACT DOCUMENTS.

Study contract documents, ascertain the most economic methods of construction. Determine the overall programme of work, gangs, plant, materials, suppliers, sub-contractors to be used. Allow for any special constraints set by construction design or contract conditions.

ACTIVITY.1.2.2. IDENTIFY AND MEASURE WORK ITEMS.

Group similar work items together and measure quantities off drawings. Calculate the material and plant resources required.

Sort work items into packages for sub-contractors.

ACTIVITY. 1.2.3. BUILD UP TAKE-OFF DOCUMENT.

Arrange work items into logical order and sequence of construction. Enter details of labour, plant and material resources required.

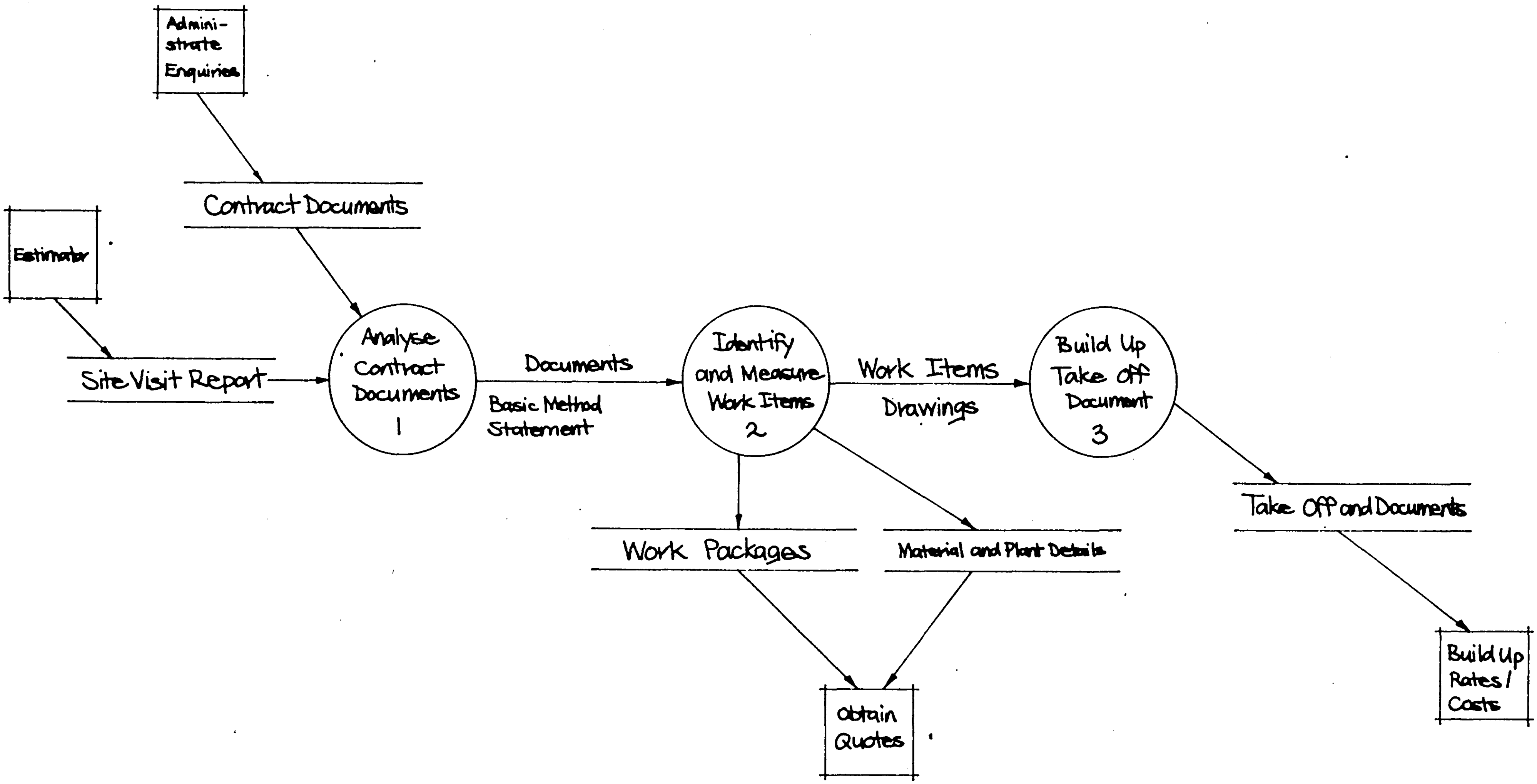


Figure 9.1.2. TAKE OFF WORK ITEMS ACTIVITY.

ACTIVITY. 1.3. OBTAIN QUOTES. See Figure 9.1.3.

INFORMATION FLOWS.

SUPPLIER FILE = *Supplier Name* KEY

+ Supplier Address + Telephone Number

+ *Details Of materials/plant supplied.*

+ Account Details + Terms of payment.

PRICE FILE = *[Material description + Plant description]* KEY

+ Cost

+ Delivery Costs + Details

+ Delivery Delays + Shortages

+ *Supplier details*

QUOTES FILE = [*Work package + Item description*] KEY

+ [(Material + Plant description)]

+ [Supplier + sub-contractor details]

+ Quote

ACTIVITIES.

ACTIVITY 1.3.1. SELECT SUB-CONTRACTORS TO QUOTE = Select sub-contractors which could undertake work proficiently from file.

ACTIVITY 1.3.2. SELECT SUPPLIERS TO QUOTE = Select suppliers which can supply goods competitively from file.

ACTIVITY 1.3.3. ANALYSE AND SELECT QUOTES = Calculate full cost of quote and relate to conditions placed on quote. Choose most competitive quote for contract.

ACTIVITY 1.3.4. PLACE ORDERS = Place order with supplier/sub-contractor whose quote was chosen.

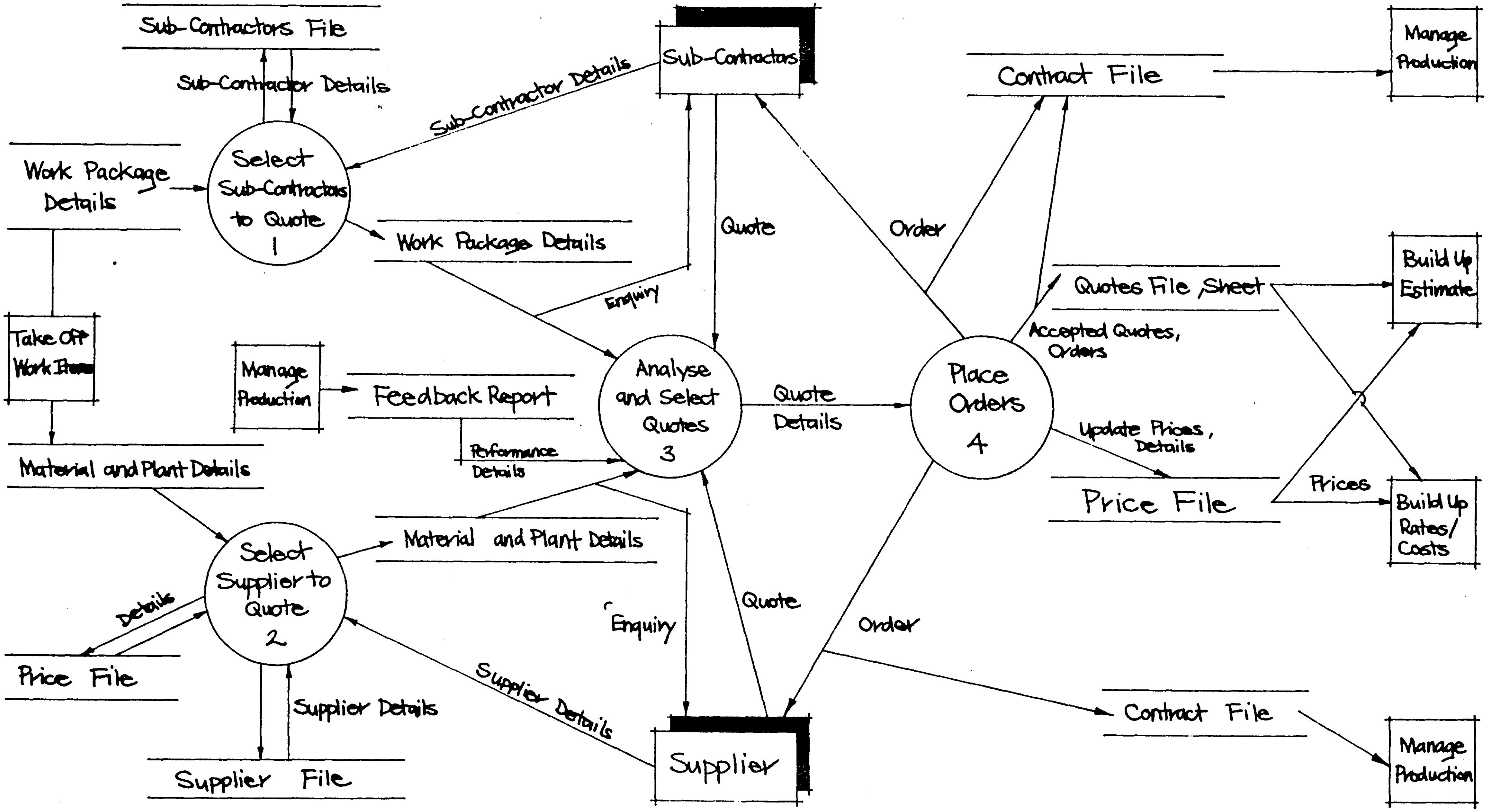


Figure 9.1.3 OBTAIN QUOTES ACTIVITY.

ACTIVITY 1.4. BUILD UP RATES/COSTS. See Figure 9.1.4.

INFORMATION FLOWS.

METHOD STATEMENT = Detailed sequence, logic, of construction
for *Work packages + items* KEY
+ *Gang size + structure*
+ *Plant needed + Duration*
+ *Materials delivery + handling details*

OUTPUT FILE = Work Item Description KEY
+ Labour description + Plant description
+ Conditions
+ [Labour output + Plant output] + Unit

OUTPUT = Work item description KEY
+ Site conditions
+ Labour description + plant description
+ Output + Unit

COST = [Description] KEY
+ Cost + Unit

LABOUR COST DETAILS = Description of labour KEY
+ Basic wage rate + Plus rates + Sick Pay Allowances
+ Allowances for guaranteed time
+ Employers liability insurance + Training levy
+ National insurance + Pension + Holidays
+ Allowances for redundancy + Benefits
+ Absenteeism + Wet time + Profit margin.

ALL-IN-LABOUR RATE = Description of labour KEY
+ All in Hourly rate
+ (Profit margin)

RATE = Description KEY

+ Cost + Unit

FINANCE DETAILS = Average costs of haulage + Unit

+ Details of extra costs

+ Overhead and Profit Requirements

ACTIVITIES

ACTIVITY 1.4.1. DETERMINE METHOD AND SEQUENCE OF WORK ITEMS = Analyse work items, group similar together. Determine detailed method of work and resources required.

ACTIVITY 1.4.2. UPDATE OUTPUT FIGURES = Calculate output achieved from target sheets, allowing for site conditions. Compare with standard output in file. Alter standard as appropriate.

ACTIVITY 1.4.3. DETERMINE OUTPUT = Analyse construction details from method statement. Find similar item in output file, compare the two and make judgement of output for item.

ACTIVITY 1.4.4. BUILD UP ALL-IN-LABOUR RATE = For each different type of labour employed, calculate average annual cost to firm. From this calculate the hourly rate.

ACTIVITY 1.4.5. DETERMINE LABOUR COST = Calculate the labour cost or rate for the work item, from the expected output per hour and the labour rate.

ACTIVITY 1.4.6. DETERMINE EXTRA COST = Analyse if any costs have not been allowed for or whether the item has a very high material cost, which justifies extra cost.

ACTIVITY 1.4.7. DETERMINE PLANT COST = Ascertain plant requirements and duration. Calculate rate from plant cost, from buyers file or quote, and duration and amount of work to be done. Allow for delivery, erection, removal, fuel, operator and any related costs.

ACTIVITY 1.4.8. DETERMINE MATERIAL COST = Obtain unit cost from buyers or quotes file. Add an allowance or percentage, for sundry items and wastage and allow for delivery costs, unloading, storage, distribution and trade discounts.

ACTIVITY 1.4.9. DETERMINE SUBCONTRACT COST = From quotes file obtain rate for item. Add allowances for any divergence from initial quote, attendance required, costs due to distributing materials and all associated labour costs.

ACTIVITY 1.4.10. DETERMINE HAULAGE COST = From finance details, calculate cost of haulage. From method statement and quotes file calculate amount of haulage required; calculate rate.

ACTIVITY 1.4.11. DETERMINE OVERHEAD AND PROFIT = Analyse labour cost for separate sections of estimate or as a whole. Ascertain profit margin, add as a percentage to labour rate or cost.

ACTIVITY 1.4.12. BUILD UP UNIT RATES, COSTS = Calculate unit rate for operation.

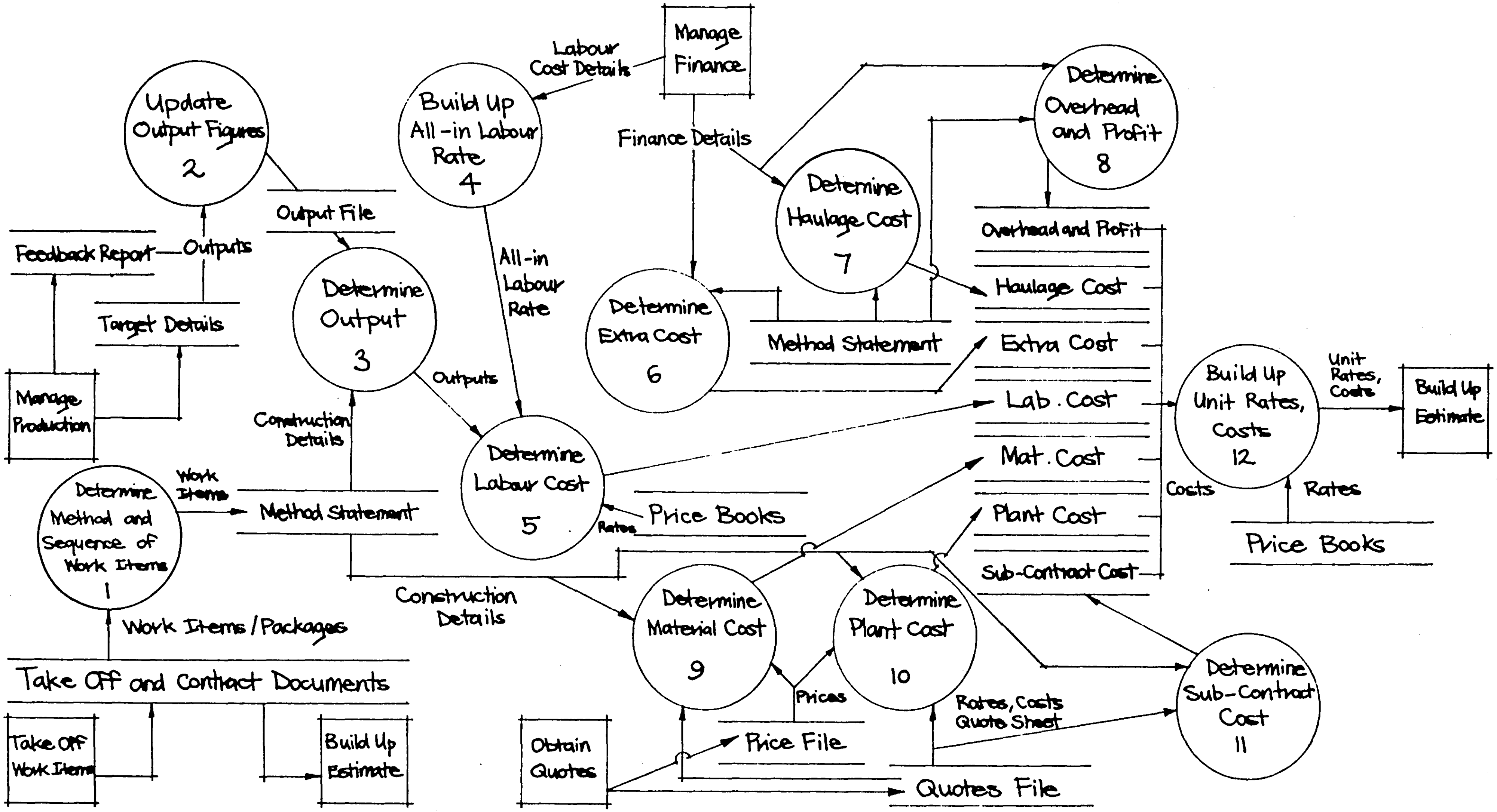


Figure 9.1.4. BUILD UP RATES/COSTS ACTIVITY.

ACTIVITY 1.5. BUILD UP ESTIMATE. See Figure 9.1.5.

INFORMATION FLOWS.

LOW AND HIGH RATES, QUOTES = [Rates + quotes] + unit.

PROVISIONAL SUMS, PRIME COST SUMS AND CONTINGINCIES = Description + Cost

ACTIVITIES.

ACTIVITY 1.5.1. CHECK RATES, COSTS, QUOTES = Go through estimate analysing and checking the build up of costs for items.

ACTIVITY 1.5.2. INPUT ALL RATES, SUMS TO ESTIMATE = Enter all final rates, costs, prime cost sums, contingencies, to estimate.

ACTIVITY 1.5.3. EXTEND AND TOTAL TAKE OFF = Calculate cost of all items, sections and total.

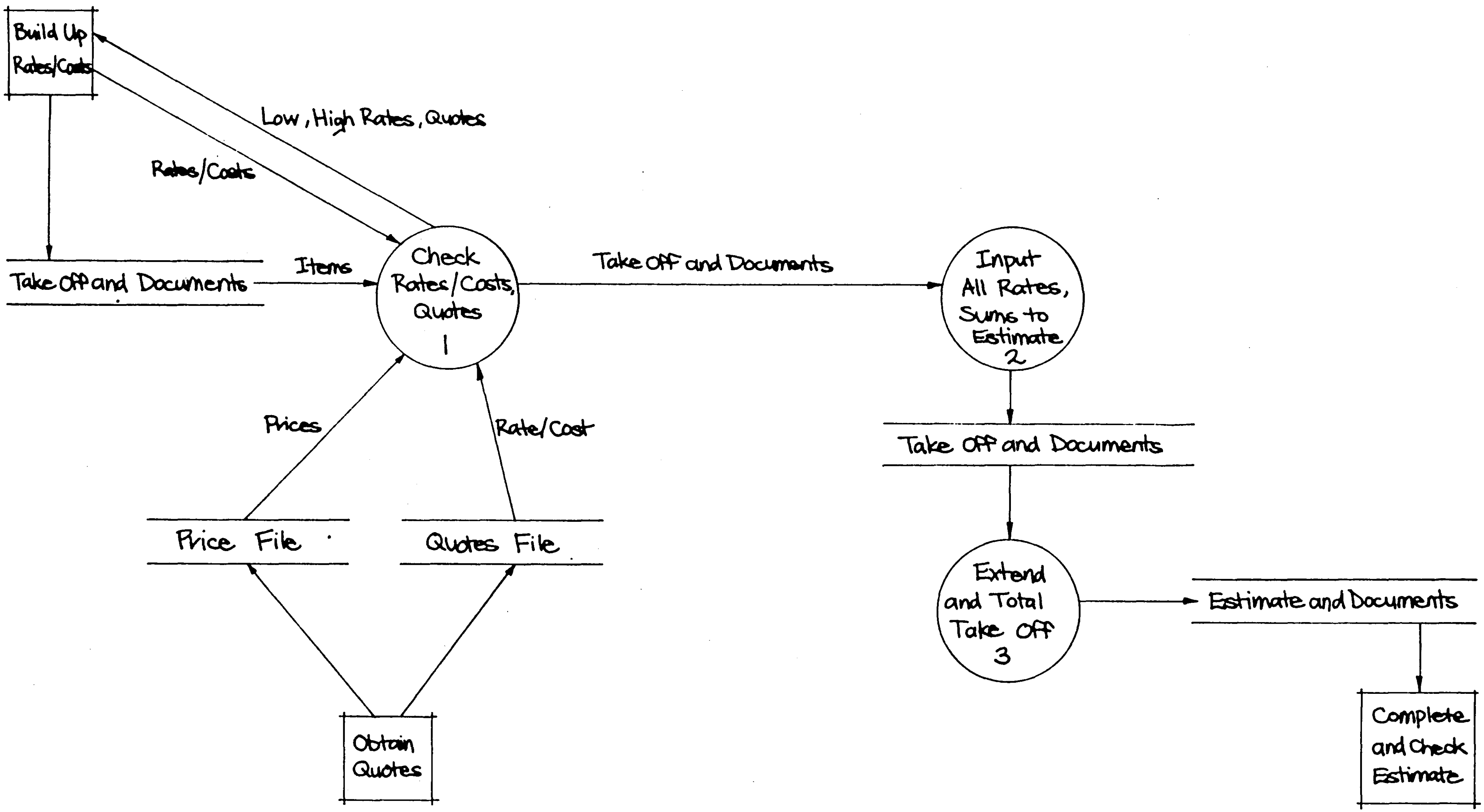


Figure 9.1.5. BUILD UP ESTIMATE ACTIVITY.

ACTIVITY 1.6. COMPLETE AND CHECK ESTIMATE.

INFORMATION FLOWS

ESTIMATE = Contract Name KEY

+ *Work Items + Work Packages*

+ *[Rates/Costs]*

+ *Prime Cost Sums + Contingencies*

+ Details of Overhead and Profit Margin

+ Totals Costs

ESTIMATE AND DOCUMENTS = Fully priced take-off

+ Drawings + Specification

+ Contract Documents.

PRODUCTION DETAILS = Forecast of future workload

+ Forecast of available resources

DETAILS OF OVERHEAD AND PROFIT MARGIN =

[Lump sum + % addition]

TENDER LETTER = (Description of work estimated for.)

+ Tender sum

+ Contract Conditions

CONTRACT FILE = All documents used to build estimate.

ACTIVITIES

ACTIVITY 1.6.1. CHECK AND CORRECT ESTIMATE = Check extending of item costs and totals. Correct if wrong.

ACTIVITY 1.6.2. ANALYSE ESTIMATE = Check section, trade, and element totals. For any that seem incorrect or anomalous, check build up.

ACTIVITY 1.6.3. DETERMINE OVERHEAD AND PROFIT MARGIN = Analyse expected rate of return for sections, trades and total. Alter rate of return or margin to make the tender more or less competitive depending on the general market conditions.

ACTIVITY 1.6.4. COMPLETE ESTIMATE = Finish estimate, check final tender figure. Send off tender letter with conditions and brief specification of the work tendered for.

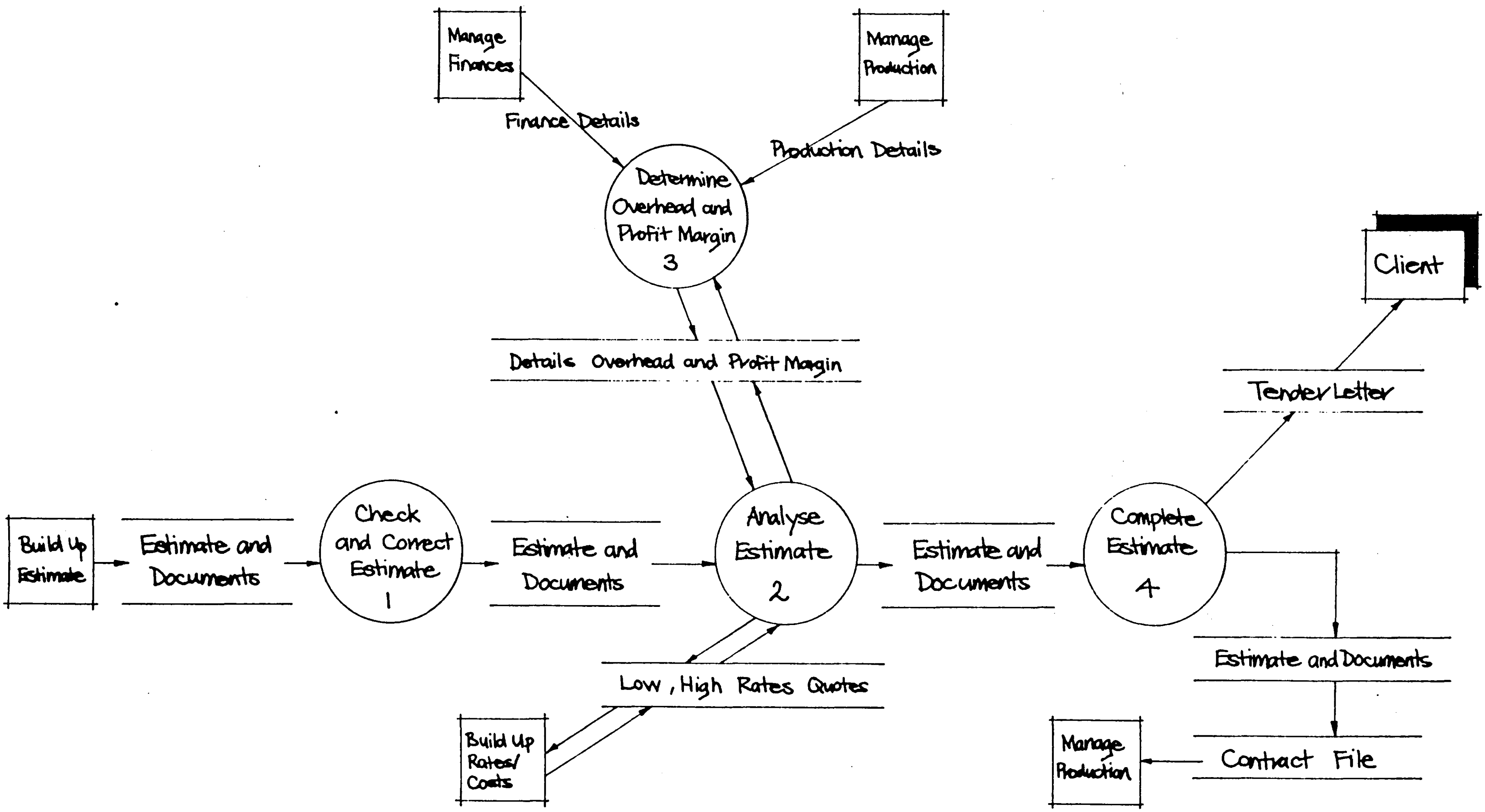


Figure 9.1.6. COMPLETE AND CHECK ESTIMATE.

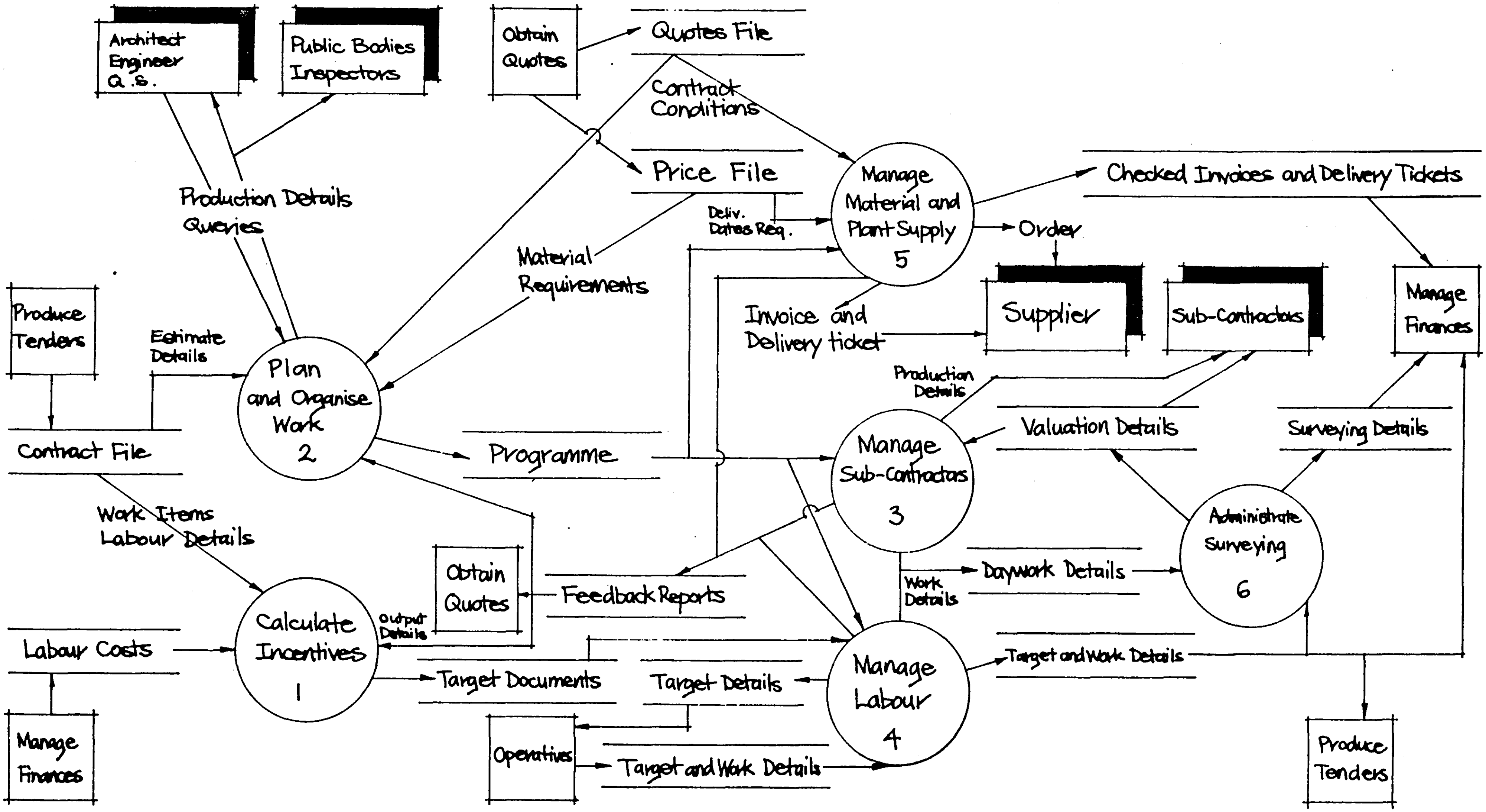


Figure 9.2.0. MANAGE PRODUCTION FUNCTION.

FUNCTION 2.0. MANAGE PRODUCTION. See Figure 9.2.0. (Previous page.)

ACTIVITY 2.1. CALCULATE INCENTIVES. See Figure 9.2.1.

INFORMATION FLOWS.

WORK ITEMS = Description KEY

+ *Estimate details*

WORK SECTION DETAILS = *Work items* KEY

TARGET DOCUMENTS = *Trade description* KEY

+ *Work Items* KEY

+ [Target hour + Piece rate]

ACTIVITIES

ACTIVITY 2.1.1. SORT INTO WORK SECTIONS = Re-arrange the separate work items into site work packages.

ACTIVITY 2.1.2. CALCULATE TARGETS = From estimate, calculate the labour content in a work item as a duration or cash sum. From this figure, and a payback rate deduced from the finance function calculate final targets.

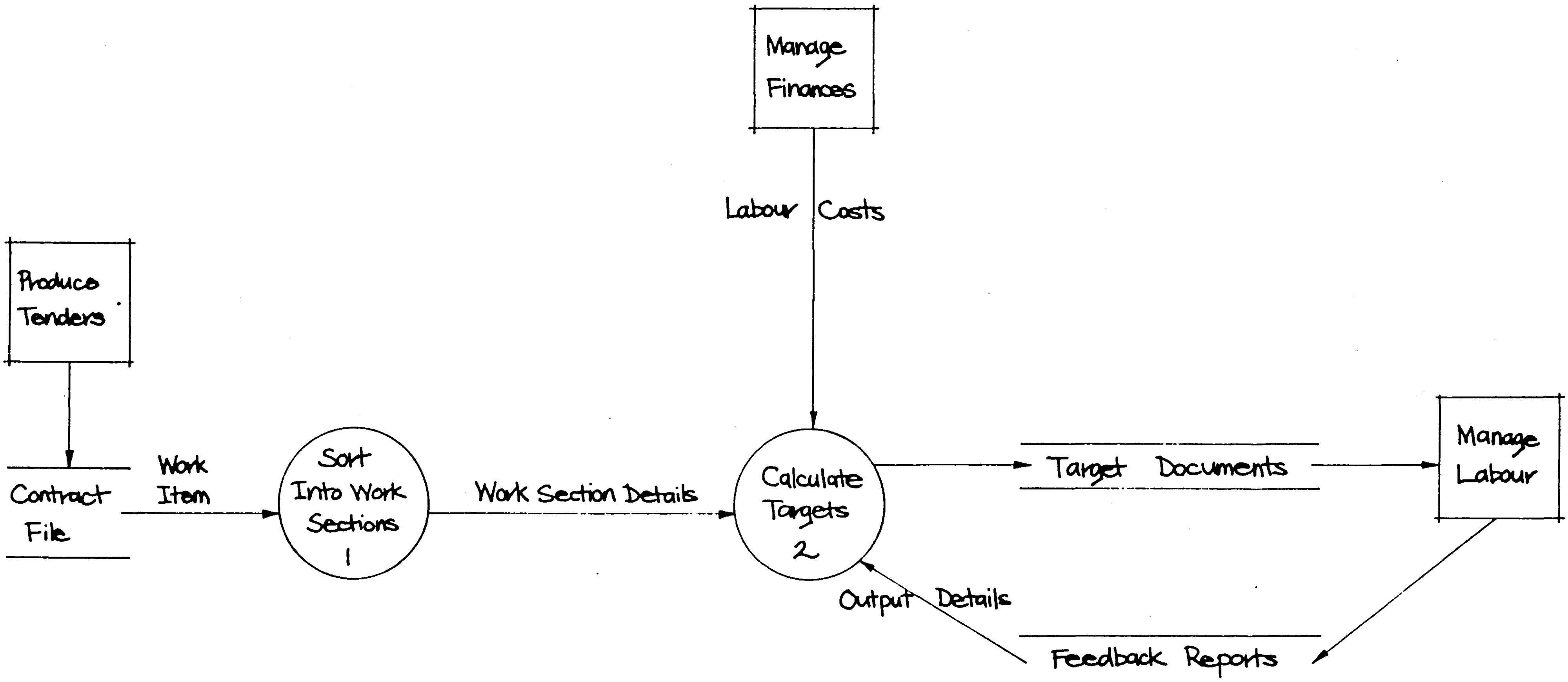


Figure 9.2.1.CALCULATE INCENTIVES ACTIVITY.

ACTIVITY 2.2. PLAN AND ORGANISE WORK. See Figure 9.2.2.

INFORMATION FLOWS.

PLANT/MATERIAL REQUIREMENTS = Description KEY

+ Operating needs

+ Start date + Duration

SUBCONTRACT CONDITIONS = Sub-Contractor's Name KEY

+ Work Description KEY

+ Start date + Duration

+ *(Materials required)*

+ Attendance Details

+ Site facilities

+ Work to be completed before commencement and during construction.

WORK SECTION AND ITEM REQUIREMENTS = *Description* KEY

+ *[Materials/Labour/Plant needed]*KEY

+ *Start dates + Durations*

+ *Buffer before start of next item*

FEEDBACK REPORT = Description of problem KEY

+ Necessary action.

PROGRAMME = Contract Name and Details KEY

* Name of trade and items* KEY

+ Calendar

INSTRUCTIONS = Name of receiver + Date KEY

+ Action required or taken

PRODUCTION DETAILS QUERIES = *Request for information* KEY

+ Date

+ (Certificates.)

ACTIVITIES.

ACTIVITY 2.2.1. ANALYSE METHODS AND ORGANISATION OF WORK = Collect all the facts about each trade or work section in terms of resources. Determine the order of construction and the time lag required between each trade.

ACTIVITY 2.2.2. PRODUCE PROGRAMME OF WORK = Draw up a programme for construction and ascertain whether the work is likely to finish on schedule. Check peak labour requirements for each trade.

ACTIVITY 2.2.3. ORGANISE WORK = Co-ordinate and control work on site using feedback from managers, visits to site, programme of work, method statement, instructions and queries.

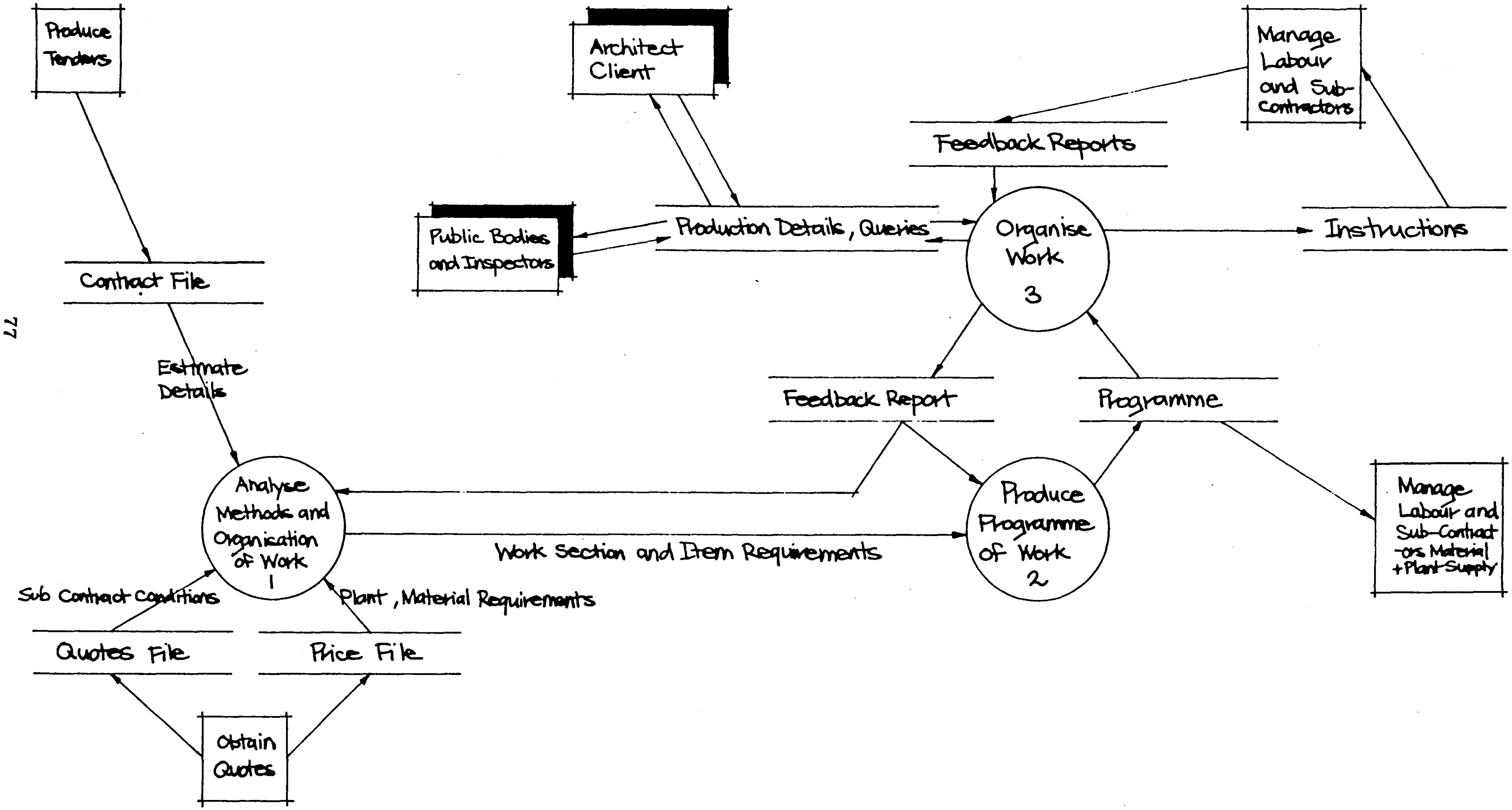


Figure 9.2.2. PLAN AND ORGANISE WORK ACTIVITY.

ACTIVITY 2.4. MANAGE LABOUR. See Figure 9.2.4.

INFORMATION FLOWS.

TARGET DOCUMENTS = Contract number + Name KEY
+ *Trade + Item descriptions* KEY
+ [Target hours / Piece rate]

TARGET DETAILS = Operatives name KEY
+ Contract number + Name KEY
+ [Target Name/Number]
+ *Trade + Item Descriptions*
+ *Days + Hours worked*

WORK DETAILS = *Description of work completed* KEY
+ *Detail of problems or daywork noted.*

OUTPUT DETAILS = *Description of work item.* KEY
+ Conditions of work.
+ Detail of gang size.
+ Hours taken to complete.

ACTIVITIES.

ACTIVITY 2.4.1. ALLOCATE TARGETS TO LABOUR = From feedback and forecast of future requirements for labour on contracts, sort out groups of items to form target sheets for the labour available. Write onto separate target sheets.

ACTIVITY 2.4.2. CHECK TIME AND TARGET SHEETS = Check figures entered onto sheets were approximately correct. Check claims for extra or daywork done, along with complaints of bad targetting.

ACTIVITY 2.4.3. SOLVE LABOUR PROBLEMS = Solve operatives problems or enquiries. Link with planning and organisation of work. Calculate outputs achieved on site for targets.

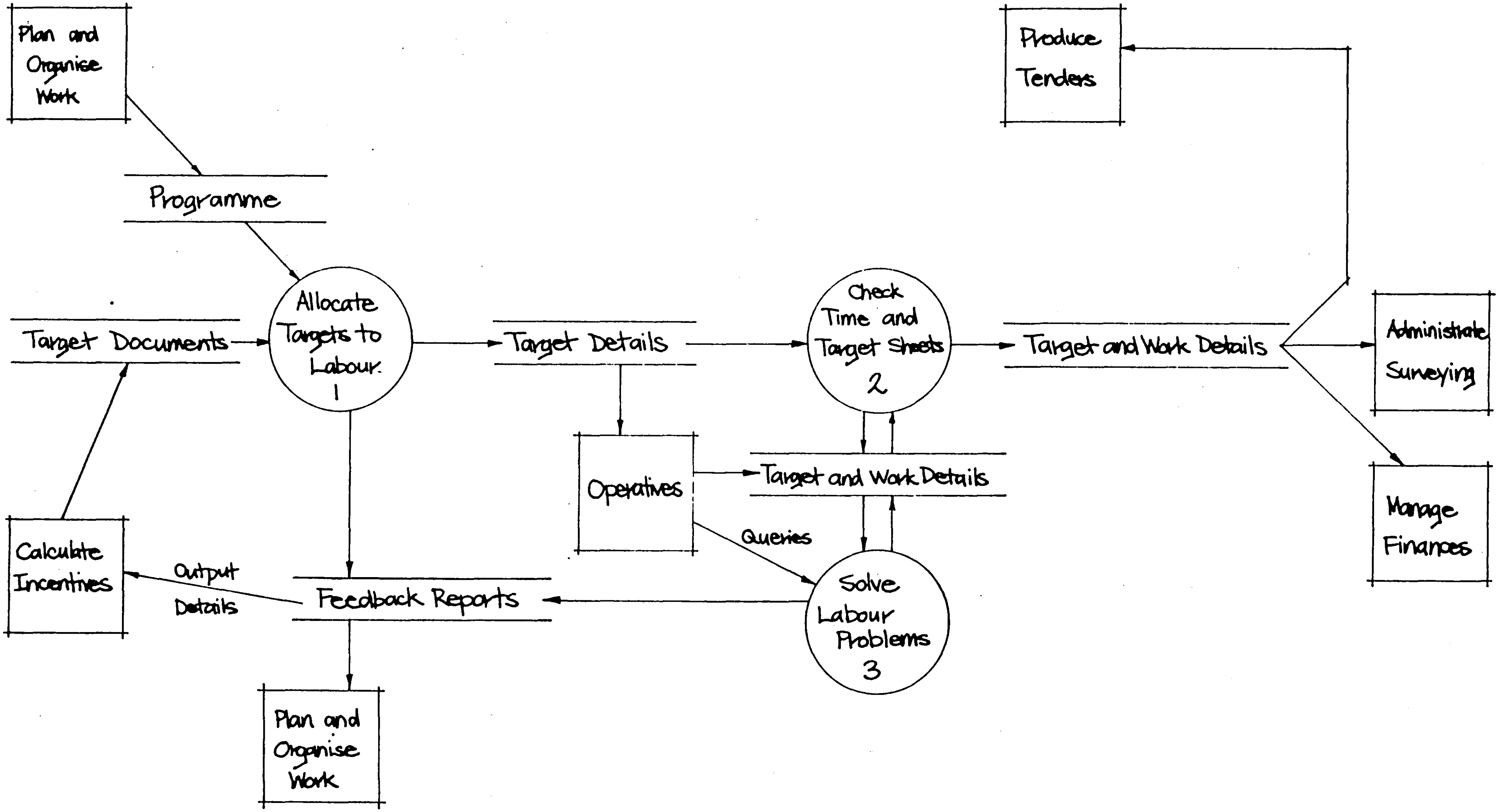


Figure 9.2.4. MANAGE LABOUR ACTIVITY.

ACTIVITY 2.5. MANAGE MATERIAL AND PLANT SUPPLY.

INFORMATION FLOWS.

MATERIAL/PLANT REQUIREMENTS = *Description of material / plant* KEY

+ Section of work required for.

+ Delivery dates.

+ Method of unloading.

MATERIAL TAKE OFF REQUIREMENTS = *Description Of Material* KEY

+ Quantity + Unit

+ Drawing Number/Item Reference/Section Of Work

PLANT REQUIREMENTS = *Description Of Plant* KEY

+ Quantity

+ Delivery date

+ Duration

SCHEDULE = *Description Of Material/Plant Items* KEY

+ Quantity

+ Delivery Date

+ Supplier

ACTIVITIES.

ACTIVITY 2.5.1. ESTIMATE MATERIAL/PLANT REQUIREMENTS.

For material requirements, measure quantities required from up to date drawings. Determine delivery dates required from the programme of work and conditions of the quote. For plant requirements, establish the plant required and the time period it was required for.

ACTIVITY 2.5.2. SCHEDULE REQUIREMENTS.

Establish the cheapest and most effective method of delivering materials to site. Make out a written schedule for material delivery dates and quantities.

ACTIVITY 2.5.3. MANAGE MATERIAL AND PLANT ON SITE.

Make out requests for future material or plant requirements indicating date required and for which part of contract they will be used on.

Manage delivery of goods on site, using information from schedule, programme and site constraints. Check delivery tickets against goods received.

ACTIVITY 2.5.4. CHECK INVOICES FOR MATERIAL/PLANT.

Check invoices from suppliers against the checked delivery tickets and order details. If correct send to manage finance for payment.

FUNCTION 3.0. MANAGE FINANCES. See Figure 9.3.0.

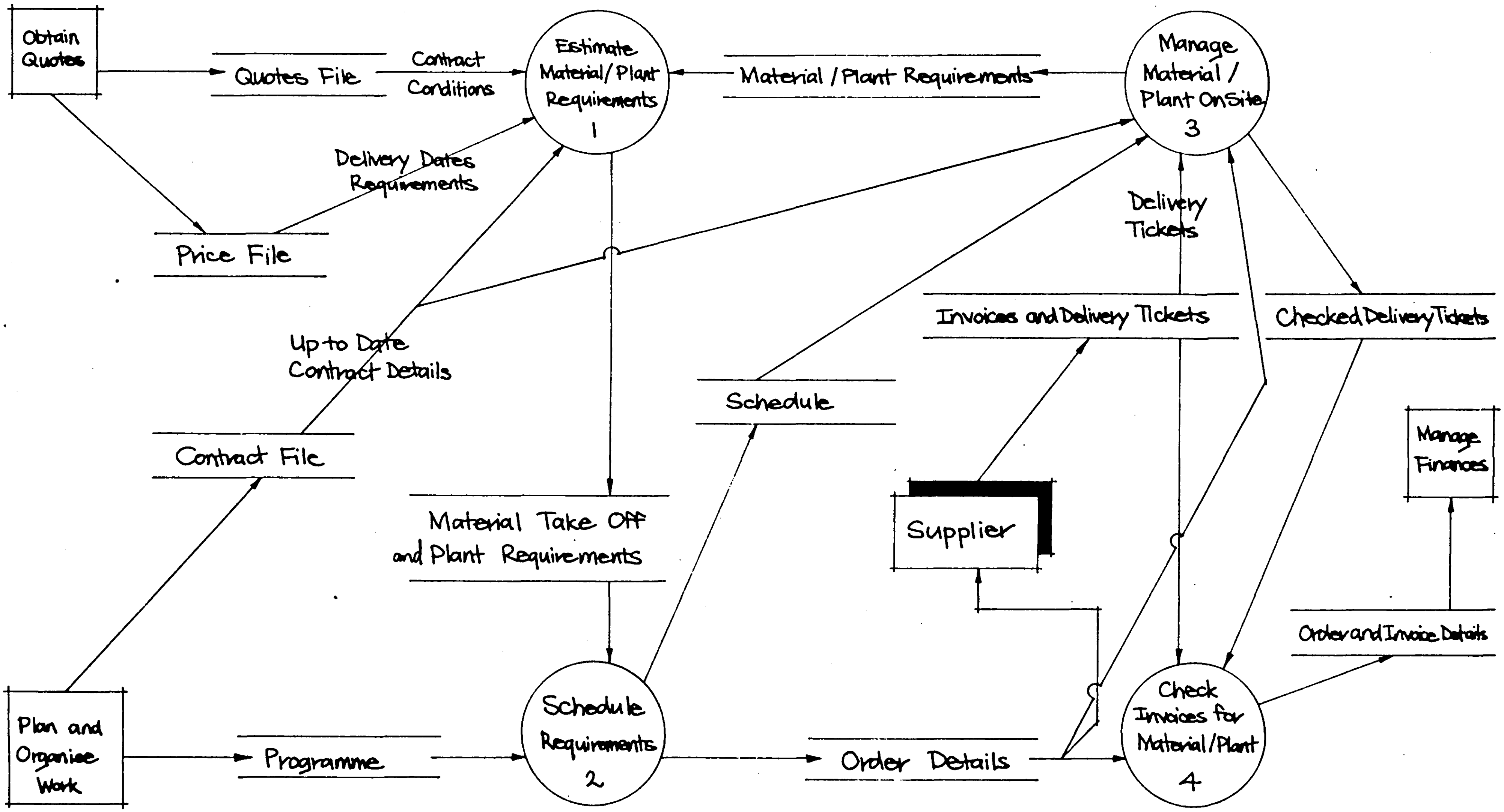


Figure 9.2.5. MANAGE MATERIAL AND PLANT SUPPLY ACTIVITY.

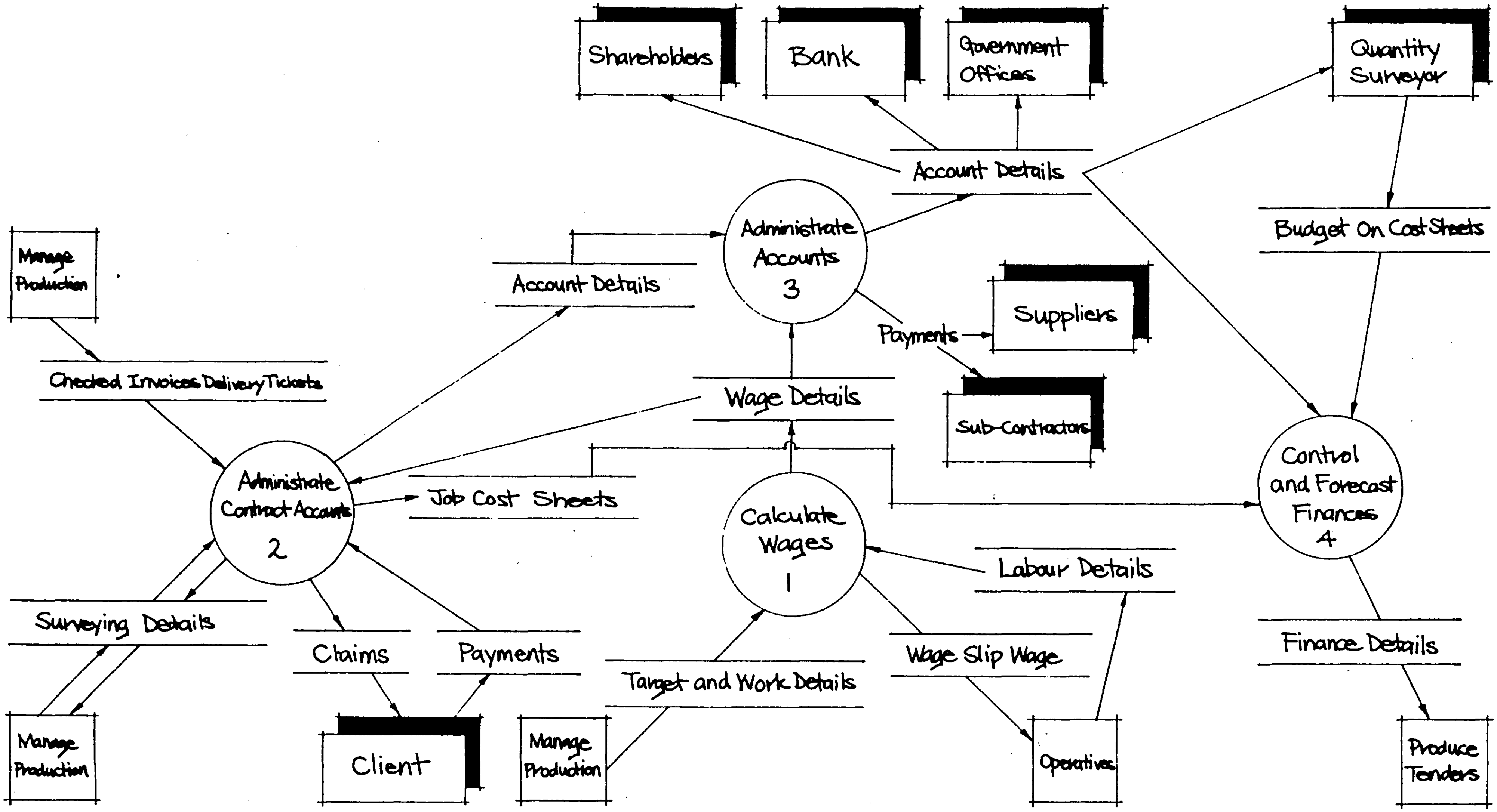


Figure 9.3.0. MANAGE FINANCES FUNCTION.

4.5. ANALYSIS OF GENERAL MODEL AND RELATED PROBLEMS.

During the analyses, problems and inefficiencies within the present systems became evident and were analysed in an attempt to identify their real causes. Evidence based upon the general model and data dictionary was used to assist analysis.

4.5.1. PRODUCE TENDERS.

Estimates and tenders took too much management time to prepare which meant that there was not enough time to carry out other functions. Estimates were produced by identifying items on the drawings and measuring off related quantities. The take-off of operations and the accuracy of estimates varied because individual managers estimated in different ways relying on their own memory and experience. None of the firms had a standard list of items used throughout the firm for estimating purposes.

Building up labour or plant costs for items varied in accuracy between contracts as no comprehensive outputs file was kept.

Standard material, plant and subcontract rates were kept in price files. Access to upto date prices was a problem due to the number of suppliers to be contacted.

Work packages let to sub-contractors were identified and written on a separate sheet as the take-off was being prepared which avoided having to sort them out later.

Throughout the production of tenders function the key to activities was through the descriptions. For example, in the take-off each item was not given a unique identifying code, but was identified through its description. Any resources for this item had to be linked to the take-off through the description of the work item or package as the key and the description of the resource. To calculate the total quantity of a material required, the estimator had to search through item descriptions and then calculate the total required which was a very time consuming activity. It could have been done much more efficiently if the information had been co-ordinated.

Basic estimating data was not kept with the estimate document. Data items such as the output rate for labour or plant items, durations and material rates were not formally organised. When the estimate was used for calculating contract management information, basic estimating data was not available, so there was a break in the data flows between the tender and production management functions.

4.5.2. MANAGE PRODUCTION.

As basic estimating data was not kept, important production management information was lost. If required later the estimate information needed re-sorting and re-calculating to be in the proper format for planning or targetting. Typical work required for targetting included the following stages;

i) Go through estimate, sort out work items on description.

ii) Calculate labour cost and duration of operation.

iii) Calculate targets for operatives.

iv) Produce target sheets by hand, one copy each for management and operatives.

This was probably the reason for contract managers relying on their experience of similar jobs to approximate targets and programme durations, as to build them up logically took too long.

As in the production of tenders function, production management data from the estimate, such as target details, was usually accessed through the description as the key. This resulted in a considerable amount of sorting through information. None of the information in the estimate was coded to make sorting easier.

The format of items in the estimate was different to that required for production management. This made sorting and calculating much more difficult.

Feedback reports were not comprehensive in their structure or detail. They were based on the 'management by exception' principle where only exceptional or inaccurate data were reported back and investigated. For example, high bonus earnings, shortages of materials and labour or sub standard work. To analyse the information held in the estimate was virtually impossible due to its format and structure. To relate feedback information to that held in the estimate was arduous and of doubtful accuracy.

Cost control for jobs was difficult to relate to trades or sections of the building as the estimate and contract management forms did not have the correct format for data to be collated quickly.

4.5.3. OVERVIEW OF PROBLEM TO BE SOLVED.

The basic problem to be overcome was that estimate information was not in a suitable format for effective use in other related management functions. Management information had to be re-sorted many times for separate activities. Basic information was not correctly stored for use in other related functions or activities.

This resulted in related management information for separate activities being derived from separate sources.

CHAPTER 5.

DESIGN OF A NEW SYSTEM.

5.1. DATA CO-ORDINATION.

The basic problem confronting the firms was using the information held in the estimate for production management. This problem was investigated by a number of working parties. (BRS:1969; BRS(J.R.Britten):1969; DOE,Housing And Construction,:1971) They defined the problems of communication and data co-ordination in general terms, as a duplication of effort and translation and regeneration of information. By this they meant that the same information was used by separate functions and each function re-sorted the information so that it was relevant to their own particular needs. This led to decisions being delayed or taken on hunch, simply because of the effort required to collect and re-sort the information.

One report specifically looked into the needs of the construction team and project information and the basic requirements for structuring project information for the construction team were laid out. Some degree of operational estimating (in consultation with project planner, buyer, and other key members of the contractor's management team) was central to effective construction management and control. (DOE, Housing And Construction:1972) The production orientated information structure provided the link to

production management. (BRS(Skoyles):1969)
More recent projects have attempted to implement integrated solutions using computer technology. (Norman:1985, McCaffer and Sher) Most of these systems integrated estimating with valuations and costs control. The more sophisticated systems related the estimate to resource scheduling and drew up programmes. These projects and other similar ones established certain aspects of construction management which could be integrated using computers. They also laid down the basic parameters on which integrated systems could be built. However, most of the systems were designed for use with bills of quantities and required a considerable amount of time to set the systems database files up. Small building firms do not have the resources to set up such systems.
A major drawback with all the systems was that the estimating information was not classified in terms of production related facets, such as target sections for individual contracts. This restricted the possibility of producing production management reports which were related to the estimate or its resources.

5.2. POSSIBLE IMPROVEMENTS.

5.2.1. PRODUCE TENDERS.

The purpose of producing estimates was to enable the firms to give realistic tenders to clients and to provide themselves with information to manage the contracts.
Due to the uncertainty of winning the contract the contractor could not afford to spend much time and money on

planning a project he may not win and therefore needed to be able to turn the estimating information to purposeful management use with the minimum of effort.

The operational method of estimating enabled consistent estimates to be produced in addition to providing more production management information. Estimate information need not be re-measured and sorted to provide related planning and targetting information. This would allow contracts' managers to use their time more effectively utilising the information rather than creating it. Reliable feedback data should become available to the estimator as the system is used on an increasing scale which was important for estimating accuracy. (Braid:1984, Wootton:1982)

The Standard Method of Measurement was unsuitable as the items do not describe the processes of production on site. Costs were computed from quantities, while recent studies have found that the proportion of costs may be as much time related as quantity related. (Forbes:1980)

Although the operational format was generally rejected by the construction industry in the late 1960's, this was probably due to the build up of bills of quantities. Bill items first had to be re-sorted into production orientated operations before they could be utilised for production management. (Ashworth, Skitmore:1983)

It was decided to co-ordinate the new system around production related operations as previous work had shown that it provided an effective way of integrating estimating, targetting and planning. Also, the majority of the firms work was based on drawings and specification contracts where estimates were produced in terms of production related items.

An operation represented the work done by a man or gang between definite break points in the production pattern without interruption by another gang. Operations become the units of production under which the labour involved can be identified and recorded throughout estimating, targetting and planning. Integration of the different activities should be simpler as they all would use information structured around operations. The structure of the standard operations required very careful thought because if operations did not represent a limited amount of work defined by break points, then the integration between the functions would disintegrate.

In order to improve the accuracy and consistency of estimates over a period of time, a small database of operations for small builders was built up, to facilitate access to standard information.

It was decided to store only a standard description, unit of measure, trade and identifying number and a labour output figure in the file. Labour outputs were stored and not labour rates as the database file would only need changing whenever the method of work altered, rather than every time labour costs rose.

Emphasis was placed on labour costs as they seemed to give rise to the greatest problems when trying to control contract costs for the four firms studied and firms in general. (Foster and Scott:1981) (See Section 3.4.)

Another factor in this decision was the work involved in producing and updating an operations file with related materials and plant resources would be too time consuming for this project and for any of the firms involved.

To be of any practical use in estimating and planning, the output should be based on accurate data as it was from this figure that labour costs and production management information would be calculated.

Most outputs derived by the firms were usually based on past experience, pricebooks or occassionally analytical data. This method of estimating did little to enhance productivity nor did it indicate the true time for the job. It was proposed to use outputs built up from work study output data, which would overcome the problem of establishing accurate outputs. (Blain:1978)

Each estimate was to be built up from a number of operations whose standard details could be altered in order to allow for specific contract conditions. Each operation in the estimate was given a unique code so that it could be identified later. This was necessary as the same operation could occur more than once in each estimate.

The main aim of the system was to integrate estimating, planning and targetting through the labour resources. A facility for including operations material, plant and sub contract rates into the estimate was provided so that a complete estimate could be produced.

The method of estimating set out in the Code Of Estimating Practice was followed. (CIOB:1983)

To enable the information in the estimate to be used for production management purposes a number of links had to be incorporated at this stage. As the operations themselves were identified by their trade, it was no problem in providing production management information related to trades.

However, other production management procedures required the information sorting in different ways. Each operation was allocated a target section for that particular contract. Target sections were related to the method of construction and planned labour utilisation.

5.2.2. MANAGE PRODUCTION.

If the tender was accepted, the estimate would be used as a basis for production management information related to the manhours included in the estimate.

The manhours would be calculated from the quantity and labour output and used as the basis for targetting and planning information.

Durations of operations had to be considered with other logical constraints such as start dates, delivery schedules for materials and the time periods required by sub-contractors so that programmes of work could be drawn up manually.

Setting of targets would be based on the manhours of operations in the estimate. As the operations were coded for trades and target sections in the estimate, it was simple to sort out 'incentive packages' which contained a number of similar operations, for example carpentry, first fix. Each target or incentive package could be 'factored' to allow for different payback systems and to allow for some preliminary costs as appropriate. (Oxley:1985) If the incentive scheme was based on financial targets the target could be calculated from the estimated manhours. The factored targets and incentive packages could be given to the operatives on printed target sheets. These sheets would be returned by the operatives, with the time taken to complete each operation entered.

It was from this data that the necessary feedback to the estimator was obtained. The feedback was in a form that the estimator could use for comparison, as all the information was based in terms of operations. The estimator could build up a better picture of the actual output by asking the contract manager about the actual conditions on site and his opinion of the outputs achieved. If necessary the estimator could change the standard outputs held in the operations file to reflect the feedback from site. The feedback information was structured in the same way as the estimate information to enable direct comparisons to be made.

If target information was not used for an incentive scheme the data still provided management with a guide to the expected durations of operations. These could be compared with the time taken and used to control productivity.

Any new system set up had to be compatible with present systems, inexpensive, quick to operate and easy to understand. (Braid:1984)

5.2.3. CODING STRUCTURE.

Although the general structure of the estimate and management information was linked using operations, other links were built into the system to enable production management information to be extracted quickly from the estimate. Estimates and operations were given codes, structured to enable the estimator and contract manager to access the data required. The different codes formed the links between the operations and estimate files and the users.

The classification and coding systems used at present in the construction industry were not satisfactory for use in this system because of their overall complexity. However, they gave a good indication of the logical breakdown of project information. (Vickery:1968, BRS:1969, Bindslev:1974)

This was used with suggestions from the co-operating firms and ideas from related studies to establish the general criteria for designing the code structure. (McCaffer, Sher and Gellatly:1984) The final code structure was simple, short and easy to understand. The detailed criteria were developed from the requirements of the system.

The code structure was formulated so that general codes were four digit alphabetic codes. This meant that codes could be the first four letters of a term or better still a mnemonic, for example, CARP - carpentry. To identify any item uniquely, a numeric code structure was used which was sufficiently large to cope with any foreseable expansion in the number of items. The codes used were as follows;

i) Operation Code - Formed of two four character codes in the form of XXXX 9999. The XXXX represents a trade, for example CARP for carpentry and 9999 is a sequence number to uniquely identify the operation within its trade.

ii) Contract Code - Formed as a six character code. It was used to uniquely identify contracts. Whether the code was numeric or alphabetic or a mixture of the two depended on the user.

iii) Estimate Reference - Formed as a four character numeric code. Used to uniquely identify each item in the estimate.

iv) Target Section - Formed as a four character code, XXXX, where XXXX represents a work package. For example first fix - FFIX, second fix - SFIX.

5.3. INFORMATION FLOW DIAGRAMS FOR THE NEW SYSTEM.

A detailed design of the new system was produced based on the analysis and suggestions put forward. The information flow diagrams relevant to the proposals made were altered to implement the new ideas. In this way, a structured set of information flow diagrams were built up to form a new system model.

The global view of the new system was unchanged as it already represented the global view of the business in relation to its enviroment. (See Figure 10.0.)

The differences between the new and old systems were defined in the data dictionary. The basic improvement was the setting up of a standard operations file with outputs. Estimates would be built up using the operations and outputs and then management information would be generated in terms of operations. (See Section 2. for Methodology.)

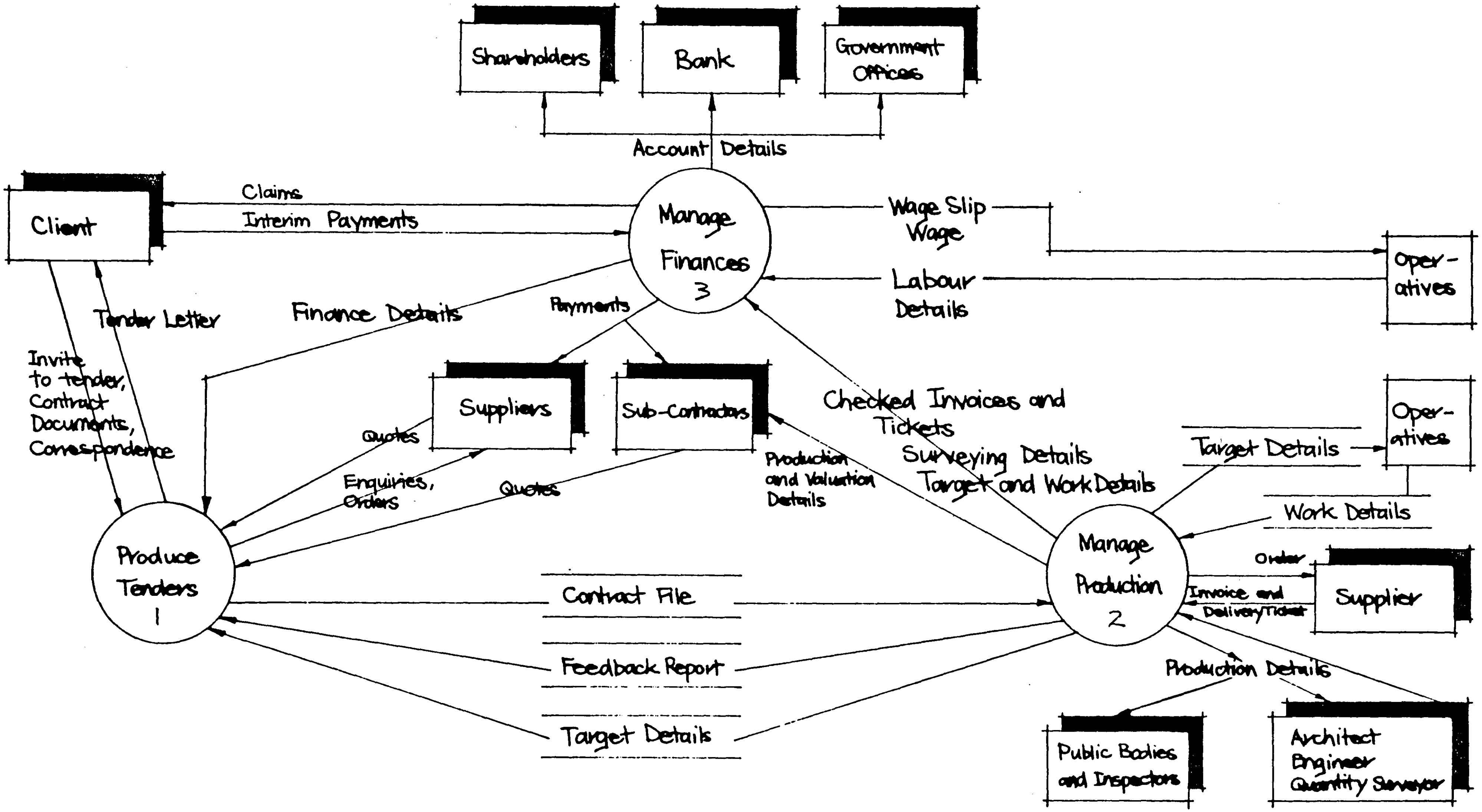


Figure 10.0. CONTEXT DIAGRAM FOR NEW SYSTEM MODEL.

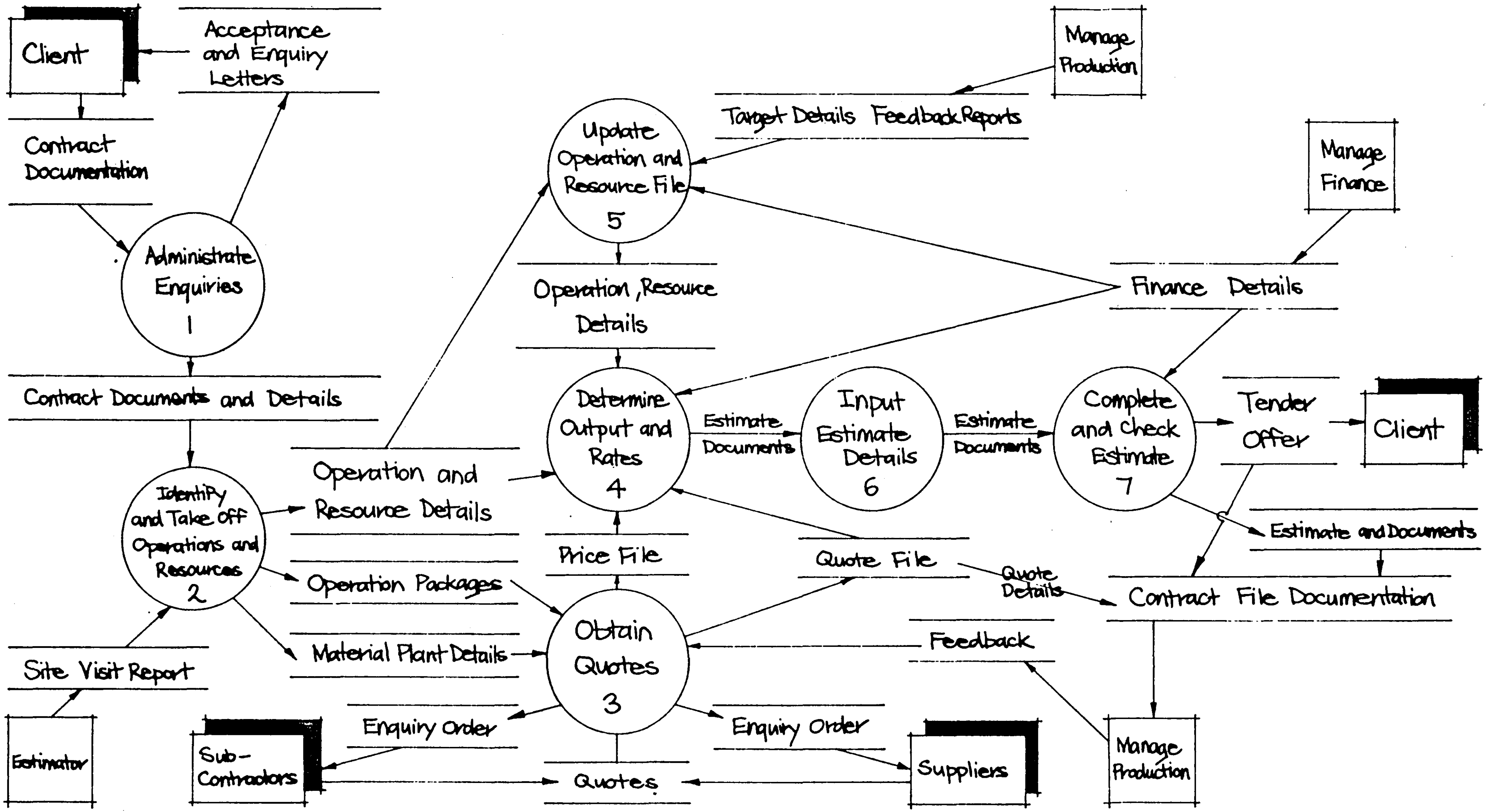


Figure 10.1.0. PRODUCE TENDERS FUNCTION.

5.4. DATA DICTIONARY FOR NEW SYSTEM.

As the information flow diagrams were changed, new data terms were used and defined to complete the data dictionary. Only the activities or flows which have changed are included in the data dictionary.

(See Section 2. for Methodology.)

DATA DICTIONARY FOR THE NEW SYSTEM.

FUNCTION 1.0. PRODUCE TENDERS. See Figure 10.1.0. Previous page.

ACTIVITY 1.2.IDENTIFY AND TAKE-OFF OPERATIONS AND RESOURCES.

INFORMATION FLOWS. See Figure 10.1.2.

Codes and Documents = *Reference code of operation/resources* KEY
+ Contract documents

Operation details = *Operation code* KEY
+ *Operation description*
+ Drawings + Specification
+ Contract of Work

Operation Packages = Package Name KEY
+ *Operation Details*

Resource Details = Resource Code KEY
+ Description KEY
+ Specification
+ Quantity + (Duration)
+ Delivery Requirements

Estimate And Documents = Contract Documents
+ *Operation details*

+ *Resource details*

ACTIVITIES.

ACTIVITY 1.2.2. IDENTIFY OPERATION AND RESOURCE CODES.

Relate work on the drawing to operation and resource codes.

ACTIVITY 1.2.3. MEASURE OPERATION AND RESOURCE AMOUNTS.

Measure from drawing quantities required for operations and resources including materials and subcontract requirements.

ACTIVITY 1.3. OBTAIN QUOTES and

ACTIVITY 1.4. DETERMINE OUTPUTS AND RATES.

See Figures 10.1.3. and 10.1.4.

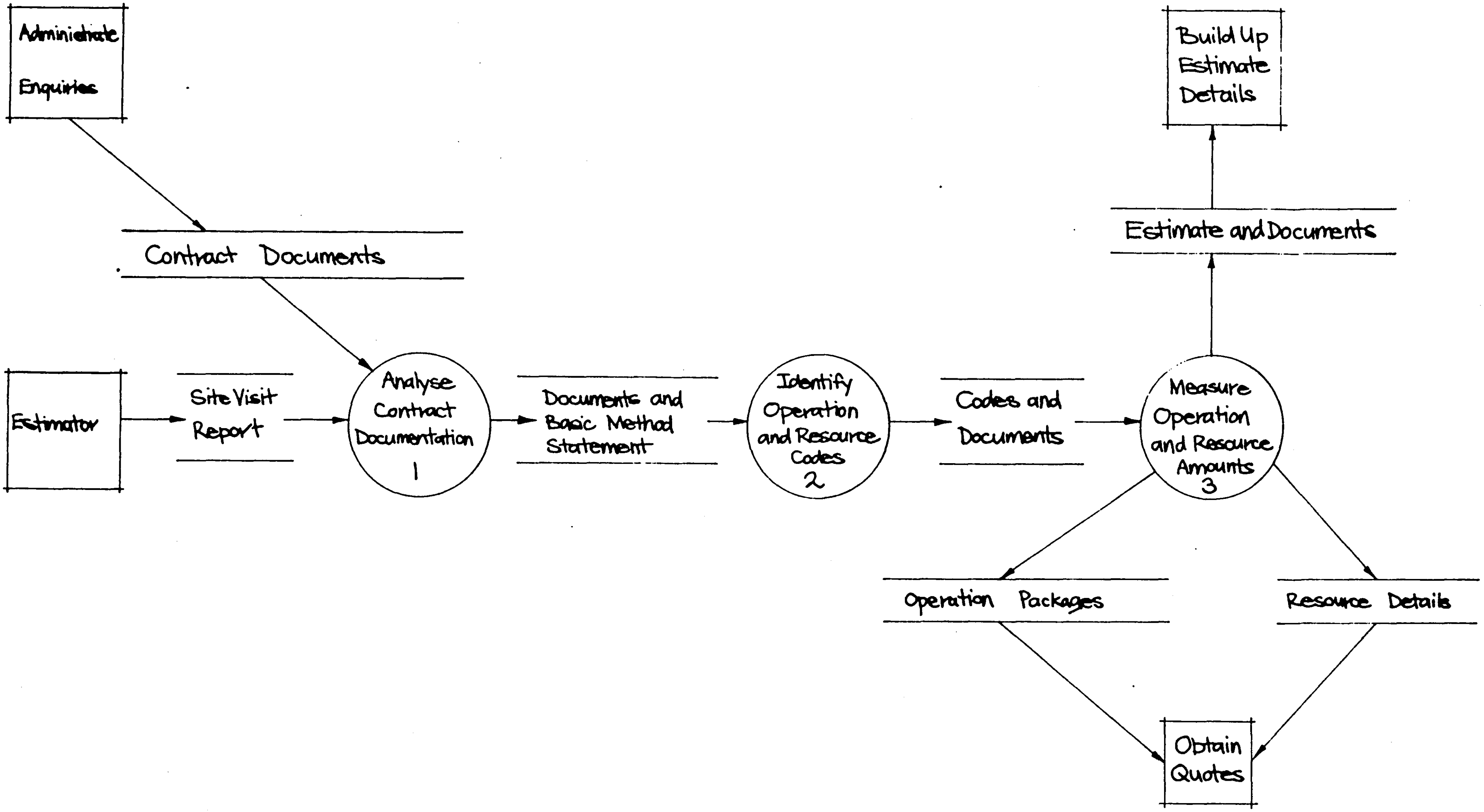


Figure 10.1.2. IDENTIFY AND TAKE OFF OPERATIONS AND RESOURCES ACTIVITY.

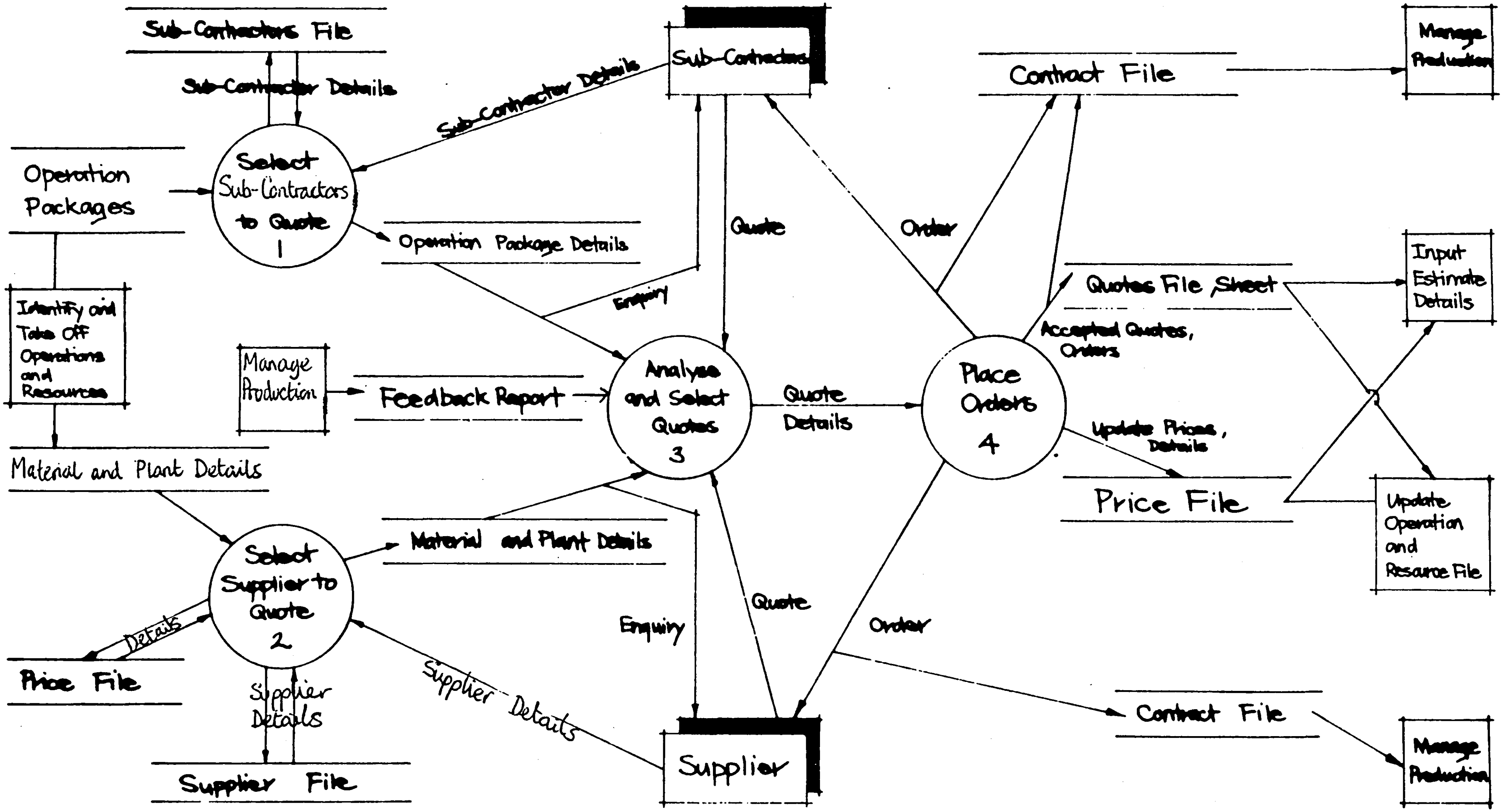


Figure 10.1.3. OBTAIN QUOTES ACTIVITY.

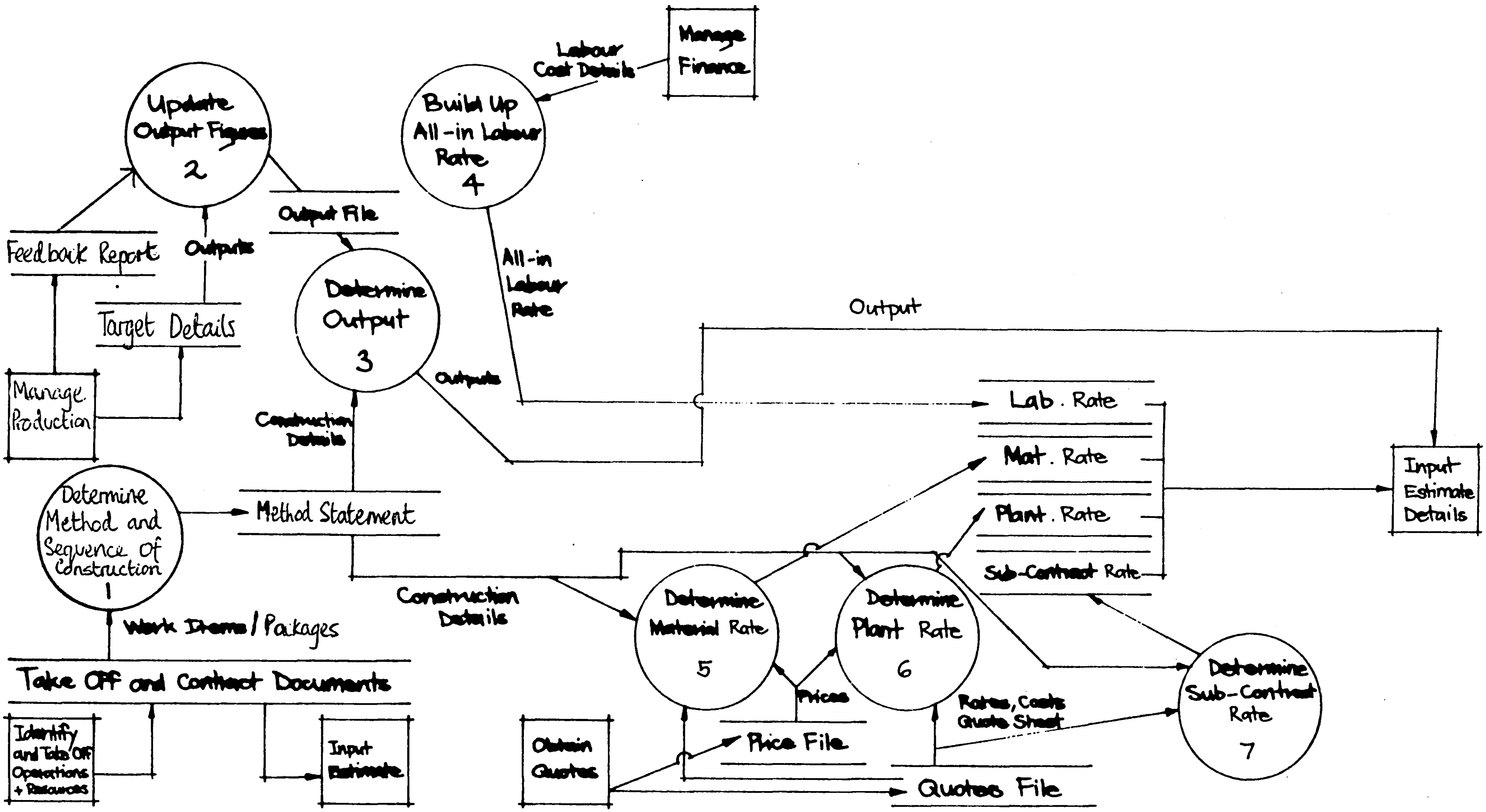


Figure 10.1.4. DETERMINE OUTPUT AND RATES.

ACTIVITY 1.5. UPDATE OPERATION AND RESOURCE FILES.

ACTIVITIES.

ACTIVITY 1.5.1. ANALYSE TARGET INFORMATION.

Calculate outputs achieved on site from target and allocation sheets and relate information to standard site conditions. Change standard output information if appropriate.

ACTIVITY 1.5.3. BUILD UP RESOURCE DETAILS AND COSTS.

Calculate all-in rates for resources.

ACTIVITY 1.5.4. UPDATE DETAILS IN FILE.

Keep all records of costs and rates upto date.

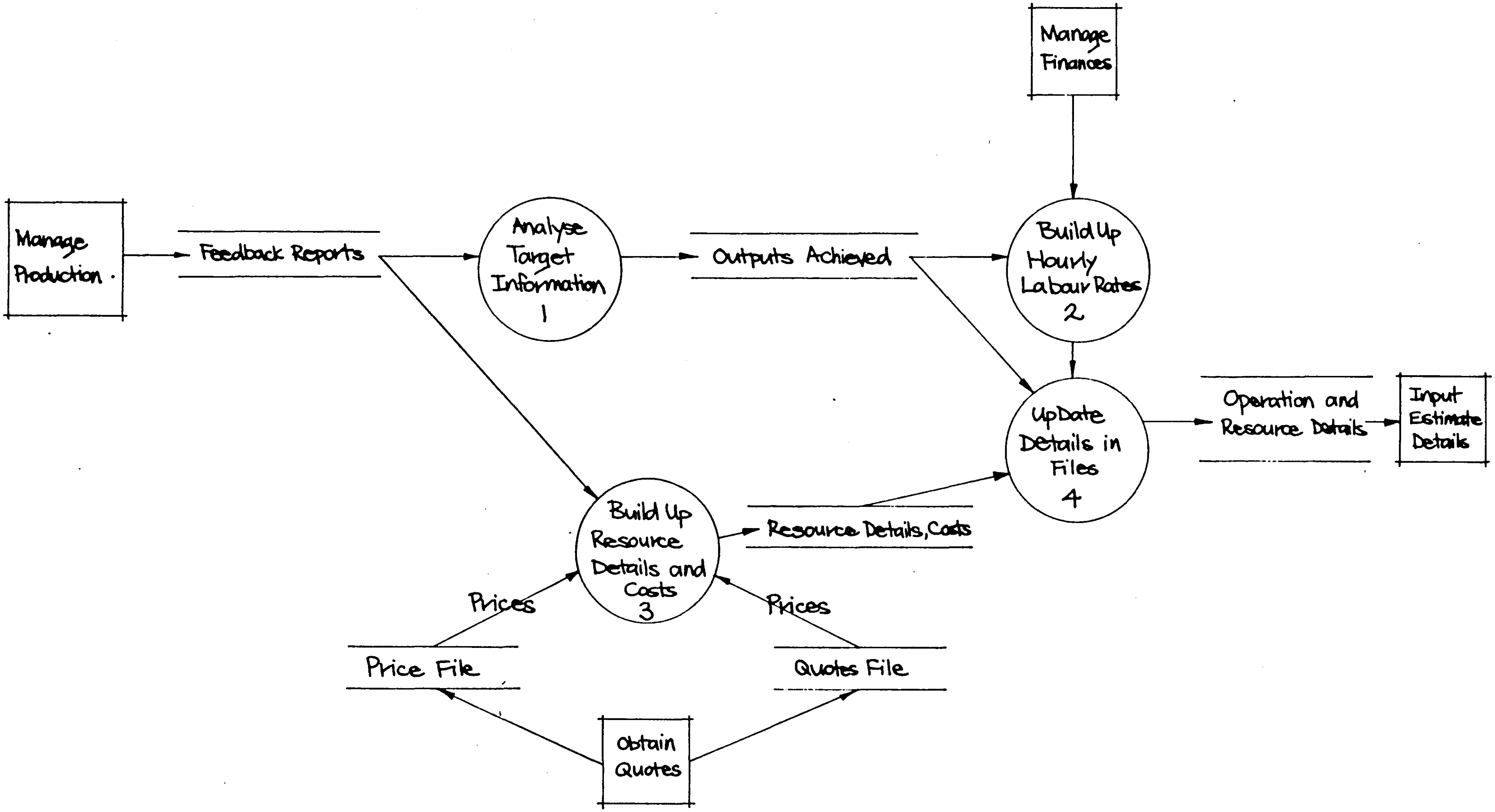


Figure 10.1.5. UPDATE OPERATION AND RESOURCE FILE ACTIVITY.

ACTIVITY 1.6. BUILD UP ESTIMATE. See Figure 10.1.6.

ACTIVITIES.

ACTIVITY 1.6.2. INPUT SUBCONTRACT, PRIME, PROVISIONAL SUMS.

Enter final details of subcontract, prime and provisional sums to estimate.

ACTIVITY 1.6.3. INPUT OPERATION AND RESOURCE DETAILS.

Enter final details of operations and resources into formal estimate document, preferably in operational sequence.

ACTIVITY 1.7. COMPLETE AND CHECK ESTIMATE.

See Figure 10.1.7.

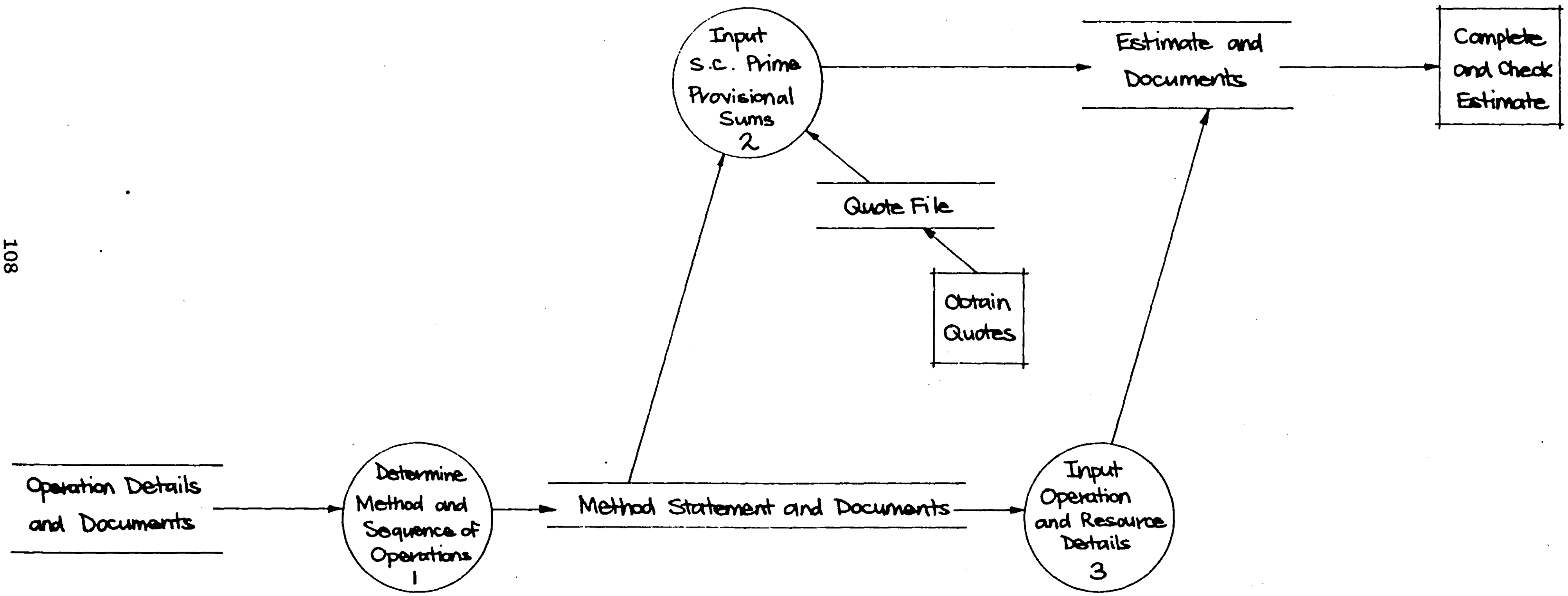


Figure 10. 1.6. INPUT ESTIMATE DETAILS ACTIVITY.

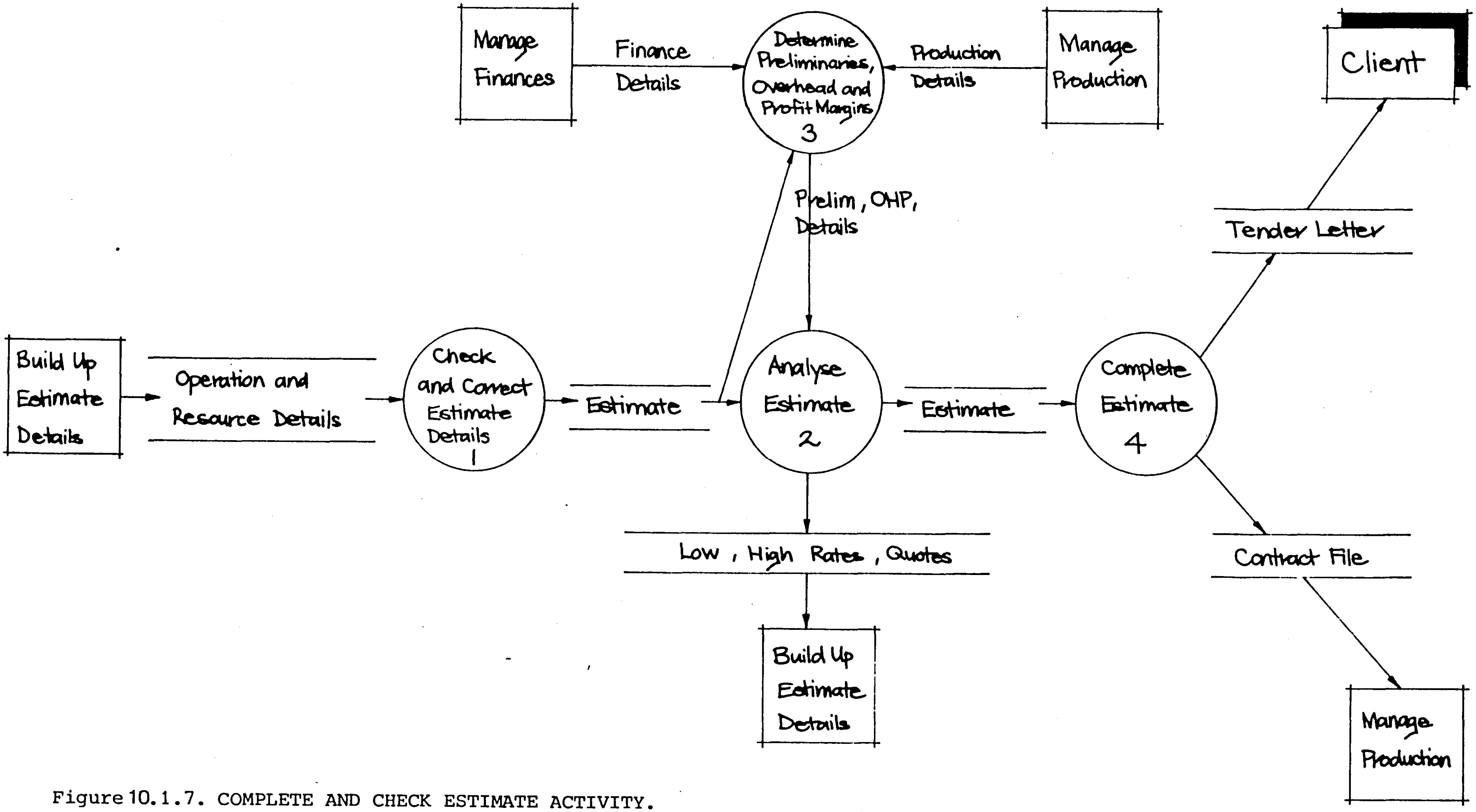


Figure 10.1.7. COMPLETE AND CHECK ESTIMATE ACTIVITY.

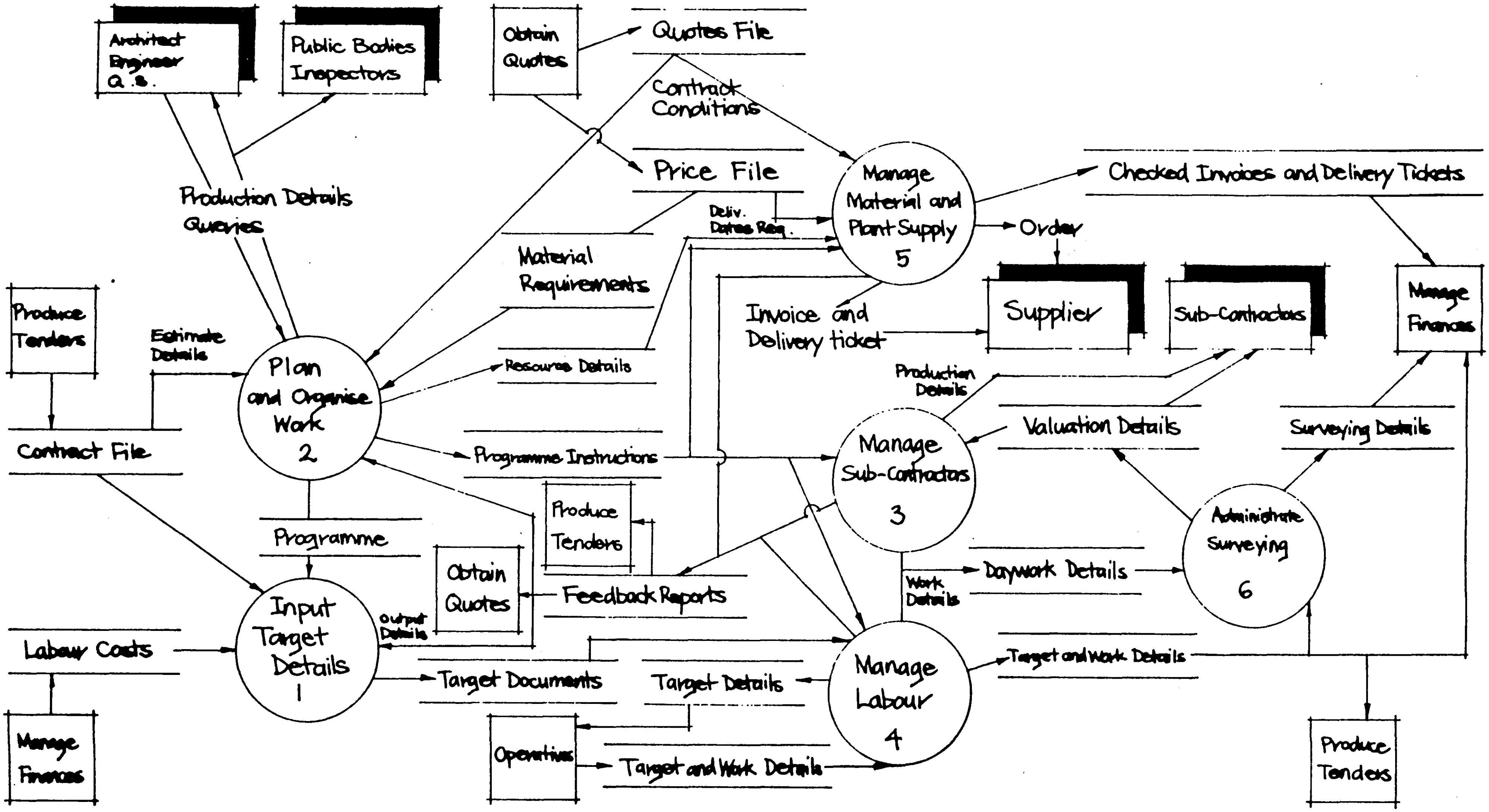


Figure 10.2.0. MANAGE PRODUCTION FUNCTION.

FUNCTION 2.0. MANAGE PRODUCTION. See Figure 10.2.0. (Previous page.)

ACTIVITY 2.1. INPUT TARGET DETAILS. See Figure 10.2.1.

INFORMATION FLOWS.

Operation Labour, Details = *Operation Code* KEY
+ Operation description
+ Duration

Trade, Target Section Details = [Trade/Target Code] KEY
+ Operation Code + Description
+ Output + Duration

Labour Costs, Factor = *Labour Type* KEY
+ All In Rate
+ Payback Factor

ACTIVITIES.

ACTIVITY 2.1.1. SORT INTO TRADE OR TARGET SECTIONS.

Sort operations into sections of work to be carried out on site. The operations may be sorted on trade, target section or as a list of operations.

ACTIVITY 2.1.2. INPUT TRADE, TARGET OR OPERATION DETAILS.

Input codes for required target section and the pay back factor for the amount of saving to be paid back.

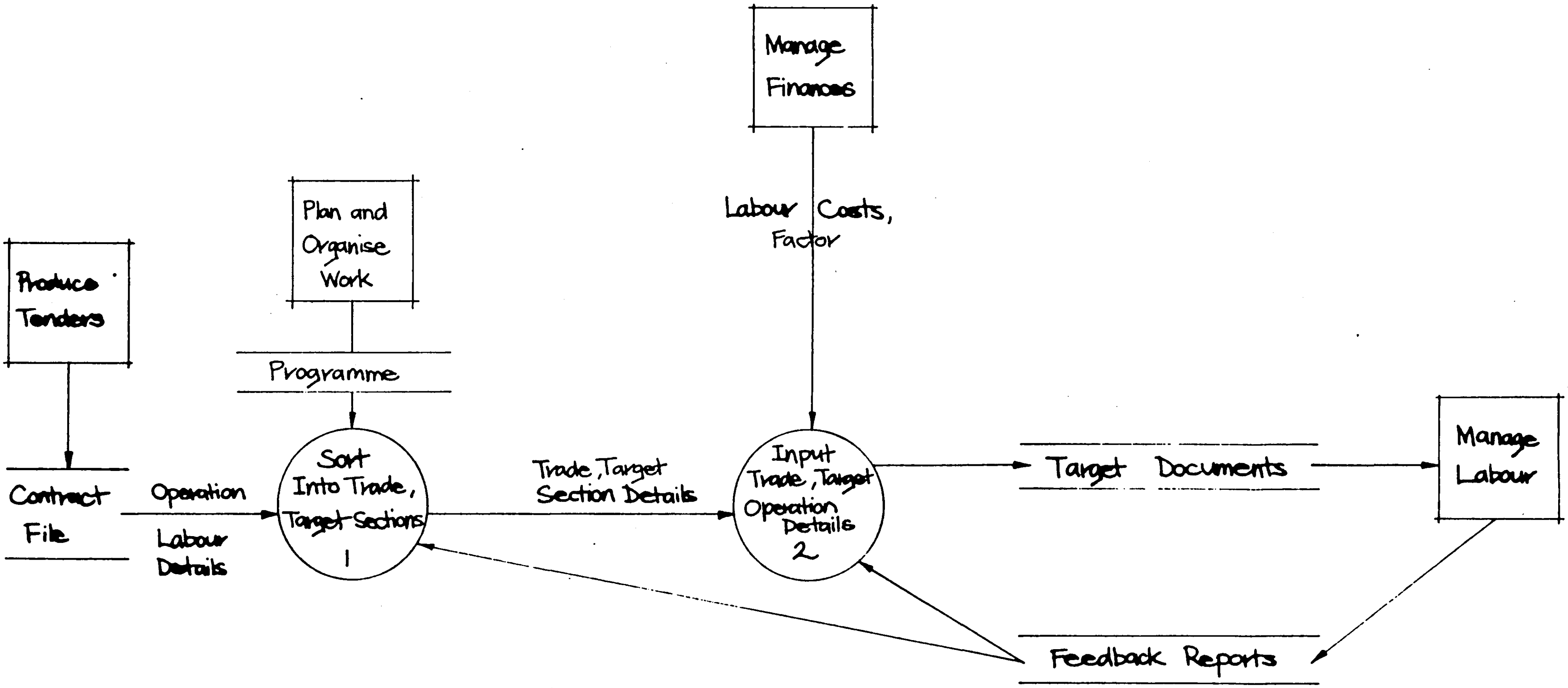


Figure 10.2.1. INPUT TARGET DETAILS ACTIVITY.

ACTIVITY 2.2. PLAN AND ORGANISE WORK. See Figure 10.2.2.

INFORMATION FLOWS.

Operation, resource requirements, durations =

Estimate reference KEY

+ [Operation/Resource Code] + Description

+ [Duration/Amount] + Start Date

+ Delivery Requirements.

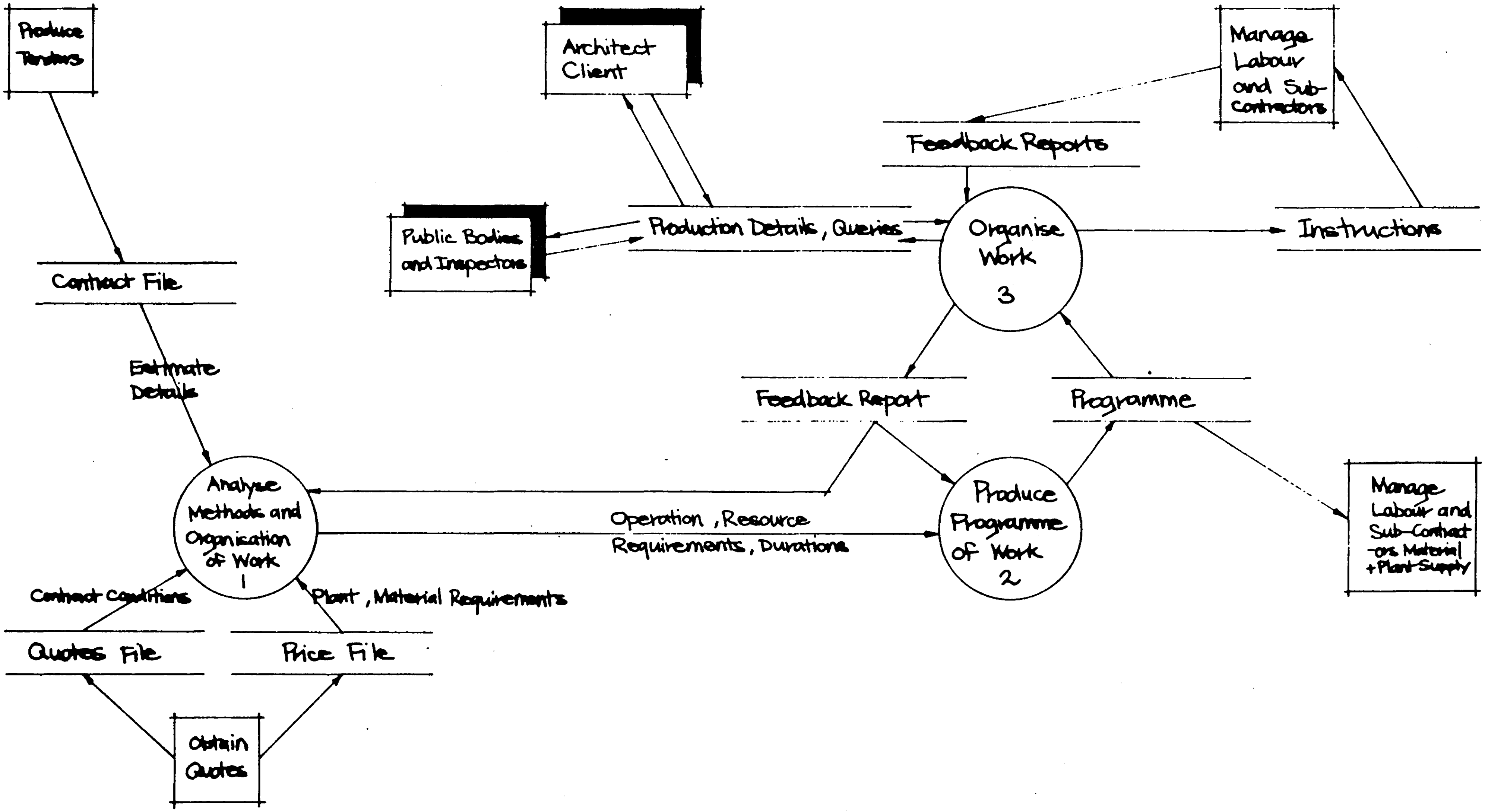


Figure 10.2.2. PLAN AND ORGANISE WORK ACTIVITY.

ACTIVITY 2.4. MANAGE LABOUR. See Figure 10.2.4.

INFORMATION FLOWS.

Feedback Reports = *Description Of Problems On Site* KEY

+ Necessary Action

+ *Operation outputs achieved on site.*

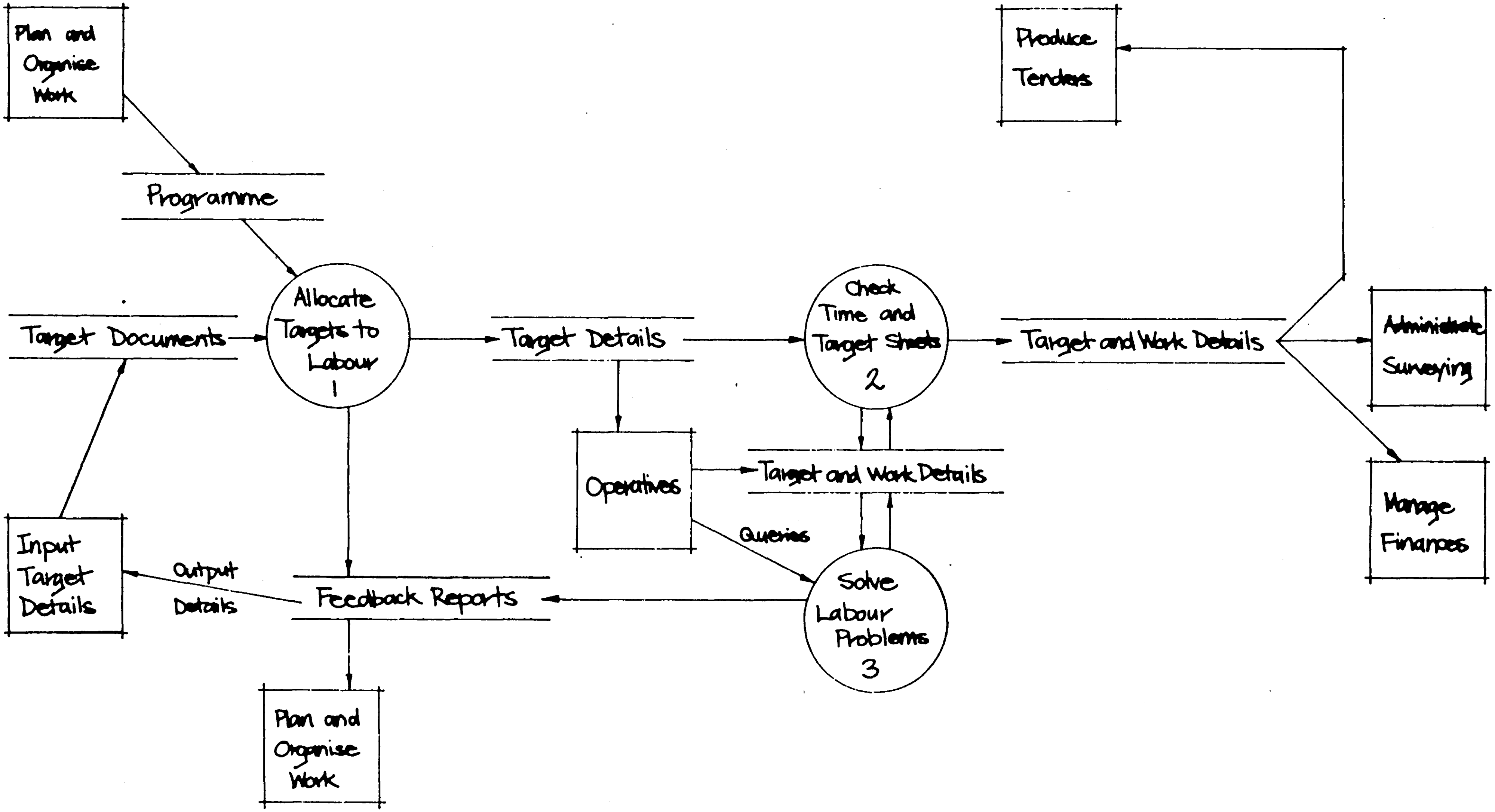


Figure 10.2.4. MANAGE LABOUR ACTIVITY.

5.5. IMPLEMENTATION OF NEW SYSTEM.

The physical implementation of the new system into the firms management system had to be carefully considered. A number of potential problems designing the new system had been avoided by involving a number of firms in the analysis and discussing potential solutions. (See Section 3.)

It was decided to use a standard micro computer database management package to implement a totally integrated system, which linked the functions together by structuring the estimating data. Estimate files were built up from standard information, which was then sorted and processed to produce information for different management functions. (See Section 5.1. and 5.2.)

Procedural programs were written to create an interactive computer system for implementation. An information flow diagram was drawn which identified the parts of the new system which were directly affected by the changes. (See Figure 11. Overview Of New System.)

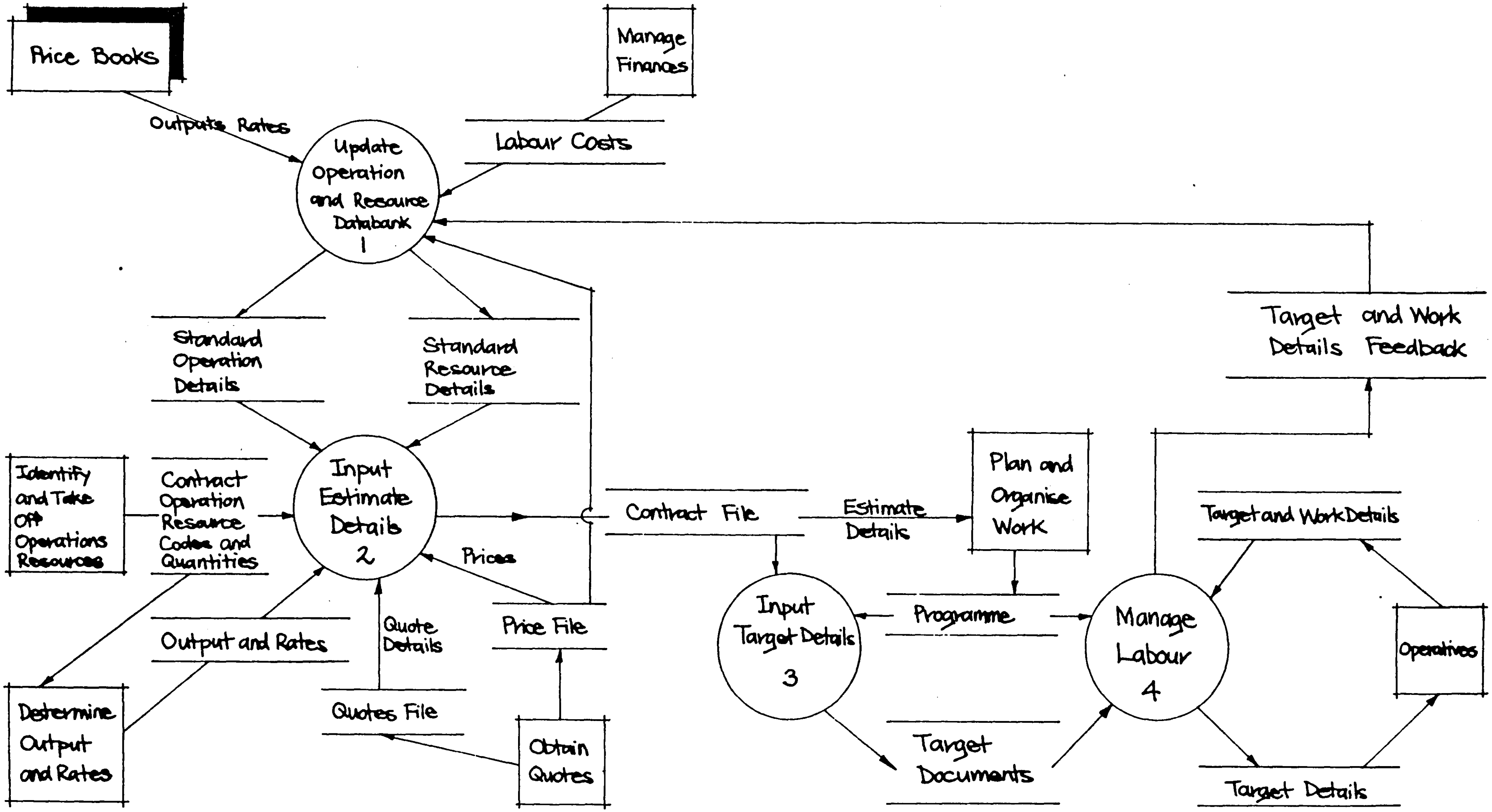


Figure 11. OVERVIEW OF NEW SYSTEM.

5.6. CREATE LOGICAL DATA STRUCTURES.

Logical database file structures were designed for efficient storage of information. Access to data was possible and future changes to procedures could be implemented without altering the file structure. In order to produce a complete data structure, a list of the attributes required in the new system was established from the revised data dictionary and new system model. (See Figure 11.) The list was then split up into a number of relations.

Relation 1. Standard Operation Details.

Trade KEY
Number KEY
Description
Output
Unit

Relation 2. Standard Resource Details.

Resource Code KEY
Resource Description
Unit
Unit Cost
Supplier
Discount Details
Delivery Details

Relation 3. Contract Details.

Contract Name KEY
Address
Client Details
Architect/Engineer/Quantity Surveyor Details
Start and Completion Dates
Preliminary Sum
Overheads And Profit Sum

Relation 4. Estimate Details.

Contract Name KEY
Estimate Reference KEY + Operation Details
+ Quantity + Target Section
+ Resource Details + Quantity

Relation 5. Target Details.

Contract Name KEY
Trade/Target Section KEY
Factor

Relation 6. Supplier Details.

Supplier Name KEY
Address
Telephone Number
Contact Name

These relations were then normalised to produce the simplest form for the data. (See Section 2.6. for methodology of normalisation.)

To reduce redundancy in the database, no derived data (durations, targets or totals) were included in the relations. This also simplified the updating of data within the database, if any attribute value changed.

Relations 1,2,3,5 and 6 were in first normal form. Relation 4 had a repeating group of data that already occurred in files for operation and resource details.

Relation 4.1. Estimate Operation Details.

Contract Name KEY
Estimate Reference KEY
Section
Trade
Operation Number
Target Section
Quantity
Output

Relation 4.2. Estimate Resource Details.

Contract Name KEY
Estimate Reference KEY
Resource Code KEY
Quantity
Cost

Each relation was in second and also third normal form, which represented the normalised data structure.

5.7. DESIGN OF A NEW COMPUTER BASED SYSTEM.

It was considered too large a task and not within the original objectives of the project to build up a database with standard files containing information about labour, materials, plant and sub-contractors.

It was therefore decided to implement only the standard operations file for the database, but allowing for the inputting of other resources during estimating using 'unit rates'.

The final relations to be implemented were;

Relation 1. Standard Operation Details.

Trade KEY
Number KEY
Description
Output
Unit

Relation 2. Estimate Details.

Contract Name KEY
Estimate Reference KEY
Target Section
Trade
Number
Output
Quantity
Labour Rate
Plant Rate
Subcontract Sum

The overview diagram for the new system was inadequate for representing the logical activities necessary to operate the new system. A logical data flow model was drawn to represent a simplified system of data inputs, outputs and activities. See Figure 12, next page.

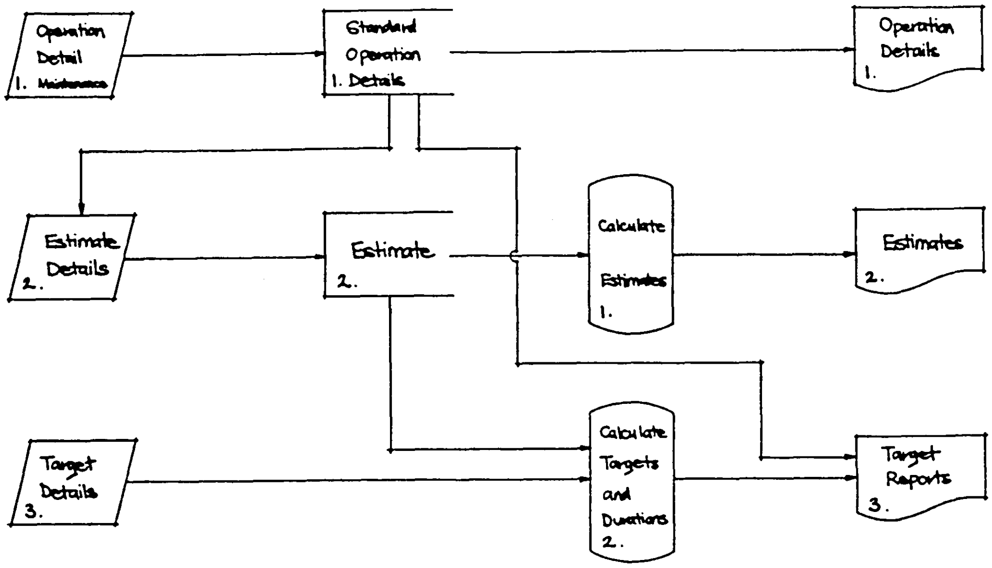


Figure 12. LOGICAL DATA FLOW MODEL.

All data inputs were to be made through fields, set up on the screen. Data outputs could be obtained from the screen or printed reports. Formats for data inputs and outputs were determined from the logical data flow model, information flow diagrams, data dictionary and reference to the standard forms used by the firms at present. These were set out on standard sheets to check that the data requirements for the inputs, outputs, processes and stores were correct. (See Appendix 2.)

The detailed design of the lay outs of screens and reports was left until later.

5.7.1. MENU DESIGN.

The whole system was designed around a hierachy of menus. Each option on every level of the menu formed a separate programme module which was integrated through the menu system. Testing and implemention was simplified as separate modules could be considered and assessed before implementation. The whole system was built up following a logical growth path based on the structured design of the new system.

5.7.2. DATA INPUT AND OUTPUT DESIGN.

The detailed design of data inputs and outputs were finalised when a full menu system had been designed and the format of inputs and outputs could be tested.

The manipulation of data in the two data stores, operations and estimates, was through screen procedures. The general points taken into account when designing data inputs and outputs were:-

i) Consistency of design wherever possible.

ii) Clarity of understanding.

iii) Pertinent information displayed or printed.

(Galitz:1982)

5.7.3. VALIDATION PROCEDURES.

All data screens and data inputs had to be 'user friendly'. The user was always informed of the possible choices and the stage of the proceedings reached. Data inputs via the screen were checked for validity, if not clear error messages were displayed showing the required format.

5.8. SUMMARY OF NEW SYSTEM.

The data was structured to enable it to be used for different functions.

The system was based on two files, a standard operations file and an estimate file. The standard operations file contained standard data pertaining to a list of operations. It was envisaged that approximately eighty per cent in value of estimates for alterations, refurbishments and repairs could be taken off using operations on file. Standard details and a performance output were stored for each operation.

Each estimate produced was in the form of operations and production details were stored in an estimate file which was used to derive production management information. There was no redundancy of data between the operation and estimate files as the data structure was analysed carefully.

The links built into the system to co-ordinate the data were based on sorting the operations into relevant groups using codes for the different functions.

The management reports which could be automatically obtained were as follows;

i) Full indexed database of operations.

ii) Complete estimates produced either for in-house or client use.

iii) Production of target sheets for use by management which could also be used for planning information.

iv) Production of target sheets for operatives.

The targetting information could be automatically collected into trades or target sections by using the coding structure.

When target information has been used for a period of time, reasonable feedback information giving generalised performance outputs on site should enable the estimator to maintain a more accurate operations file.

The layout of the estimate would facilitate cost control of the contracts as a detailed breakdown of operations and their resource costs were available from the estimate.

CHAPTER 6.

IMPLEMENTATION OF THE NEW SYSTEM.

Much preliminary work was necessary to ensure that the implementation was successful. The general method of designing the new system helped significantly as all ideas were discussed and appraised with the firms.

The three major modules of the new system were;

Standard Operation File Module.
Estimating Module.
Targetting And Planning Module.

The development and implementation of each module is set out below.

6.1. DESIGN OF A MENU STRUCTURE.

The menu system was designed to link the modules logically. The user was automatically given the top menu level after the system had been initially set up.

A number of options were available to him at the top level menu. When the lower levels of the menu were used the options were performed in a continuous loop to save time in operating the system. (See Figure 13.)

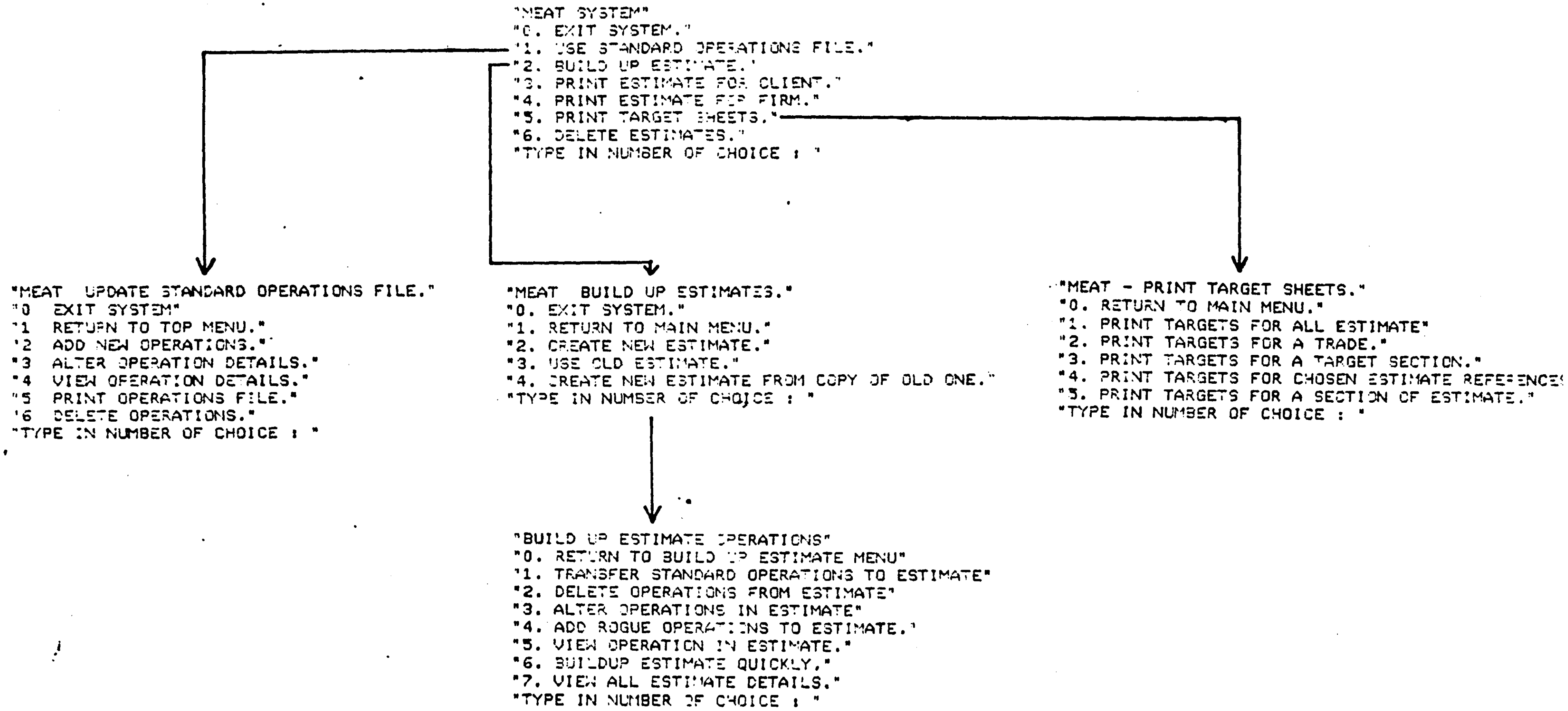


Figure 13. MENU STRUCTURE FOR MEAT.

6.2. STANDARD OPERATIONS FILE MODULE.

6.2.1. ANALYSIS OF OUTPUT DATA.

To build up a database of operations with performance data, a reliable source of data was required which would form the basis for producing estimates and related control information. If inaccurate data were used to build up estimates, it could have led to uncompetitive or unprofitable tendering.

A number of sources of information were investigated to determine the basis for the data. Statistical analyses of a number of price books and other published data were carried out to assess their accuracy as the collaborating firms used them for reference. The conclusion drawn from these tests was that for the trades studied, the difference between the books was significant. This indicated that the information in the price books varied significantly and was therefore inaccurate and not suitable for use. (See Appendix 3.)

6.2.2. OTHER PERFORMANCE DATA.

Other sources of performance data were collected in an attempt to find a suitable one. Work study based outputs should provide a more accurate and reliable source of data. A number of sets of work study data were collected from this country and abroad as follows;

i) The Department Of The Navy (USA)

ii) The Research Institute for Labour Economy in the Building Trades. (The Netherlands.)

iii) Local Authority building work values.

iv) Department Of Enviroment.

The sets of data were studied to ascertain which would be the most realistic for use by small builders in Great Britain. Unfortunately the sets of data were not comprehensive enough to establish a database with sufficient items to cover the majority of operations. Also, the environment from which the data was collected was substantially different to that found in Great Britain. For example, bricklayers in Holland used different sized bricks and methods of work to those in Britain. To have altered the data into a suitable format would have been too time consuming and was therefore not carried out.

The Local Authority data would have been suitable for some trades, but for reasons of confidentiality it could not be used.

6.2.3. FEEDBACK PERFORMANCE DATA.

As no source of published output data was available for creating a databank, performance data established by a small building firm was used.

When other firms use the standard database they will have the option of modifying the data for their own use. Consequently over a period of time the original database will be transformed to reflect the needs of individual building firms.

6.2.4. IMPLEMENTATION OF THE OPERATIONS FILE.

The first step taken was to produce an initial list of operations for discussion with the collaborating firms. A list of operations was made up for the trades in which operatives were already employed. The list included a short description and the appropriate unit of measurement. (See Appendix 4.1.)

Three firms agreed that the format of operations were suitable but stated that the database should contain the majority of operations required for each estimate. The one other firm had doubts about the operations as they based their measures on the Standard Method of Measurement.

It was agreed to incorporate enough flexibility in the system to allow individual firms to alter and add to the database to match their own detailed requirements. The original database would still be in terms of operations, but some would be broken down into their separate elements to make the system more flexible for individual firms requirements.

However, this was not done for most items as it would have destroyed the operational nature of estimates and therefore limit its use for targetting and planning. The format of the operations file was laid down during these discussions. It was decided to build up a database which contained about eighty per cent of the major operations required for estimating alteration, repairs and refurbishment type contracts.

The attributes to be stored against each operation were determined from the data analysis carried out previously. (See Section 5.8.)

To test the database and coding structure, procedural programs were written which enabled the system to be operated using a standard database package on a micro computer.

Operations were entered into the standard operations file for typical domestic refurbishment and alteration contracts. Whilst this was being done, limiting operating characteristics were altered. The most limiting characteristic at this stage was the operation code. Originally each operation was identified using a code in the form XXXX 999, for example CARP 123. The database file was printed out indexed on this code. It soon became apparent that the numerical part of the code was too limiting (upto 999 operations in each trade) so an extra digit was added which enabled each trade to contain 9999 operations.

The estimating module was then added to the system. It was found that searching the operations file was time consuming because it was indexed in order of trade and operation number. To decrease the search time, each operation was given a sub trade and the database file was then indexed on trade, sub trade, number, unit and the first four letters of the description. The first four letters of the description was indexed to enable a key word to be placed at the start of the description to further aid the search. The sub-trade was not used in any other module of the system.

The file was then printed in order of its trade, sub-trade, operation number, unit and description. A typical operation would be;

Trade - CARP Operation Number - 124 Sub-trade - CARC,
Description - Skirting upto 100mm deep.
Unit - M. Ouput - 0.15 hrs/M.

See Appendix 4.2 for the final operations database file. The procedures allowed any user to alter or add any of the details in the operations file to match their own requirements.

6.3. ESTIMATING MODULE.

The design of the estimating module and the formats for data inputs and outputs were discussed with the firms during the analysis of their management systems. To be of use to them, the new system would have to fit in with the other management systems already in use. (See Section 3.0.)

It was decided to write the estimating module in stages. The first stage was to produce estimates for labour costs only. (See Appendix 4.3.) This allowed the format of estimate inputs and outputs and the procedures to be tested and modified before the system was completed. These were found to be suitable except for the sequencing of the estimate reference. Initially the references were sequenced to automatically increase by one which meant that if operations had to be added later in their correct order the numbering and structure of the estimate was not suitable. To overcome this the estimate reference was sequenced to increase in fives. This allowed extra operations to be added later where required.

The procedures to produce a complete estimate with labour, plant, material and subcontract costs to each operation, were then written and tested. An estimate which had already been produced manually, was entered into the system. This allowed the system to be initially tested using real information. The mathematical and sorting processes were checked to be functioning properly.

Estimating data for material and plant was not included in the standard database files and had to be entered manually into the system. However, the main point of the system was to link the estimate through the labour resource for targetting and planning and it was felt to be outside the scope of this project to produce a sophisticated estimating system to cover all resources in detail.

It was realised early on in the research that certain types of contract had many similar operations in the estimate, eg. refurbishments and house extentions. (Crabb:1985) If standard estimate files were created for each contract type which had similar operations, with relevant information for outputs and rates included, these could be copied for each new contract to be estimated. The new copied estimate details could be altered to suit the specific contract operations, quantities, outputs and costs.

This resulted in much quicker estimating. After these modifications had been built into the system and tested, it was tested on a live project and compared with the actual

contract information. (See Appendix 4.4.)
During testing, it became apparent that the system could be used successfully for processing variation orders from the client. The original estimate could be copied to form a new estimate and the variation order details could be entered into the new estimate. This could then be used by management to produce claims for extra payment and to substantiate claims for extra time needed to fulfil the variation order.

6.3.1. METHOD OF ESTIMATING.

The identification of operations and the measurement of quantities off the drawings had to be produced as before. As the take-off was being prepared the estimator would enter the code for the item if it was held on file, eg. CARP 123. If the operation was not on file an 'R' was written next to it to signify it was a rogue item. The details could then be entered to the system.
Each contract had to be given a unique code to create the necessary files. For each take-off item, the following details had to be entered.

i) A unique estimate reference was automatically assigned to the item by the system and against this was entered the trade and operation number. The reference could be altered if required.

ii) The operations standard details were displayed on the screen and details entered relating to its quantity, target section, output, labour, material, plant rates and a subcontract sum. To facilitate entering information screen fields were automatically transfered to the next screen. This was found to be most useful for the target section and labour figures. Only fields that changed between items had to be edited. In most cases, operations would be entered in construction sequence and only the quantity, output and material rates required changing regularly.

iii) Rogue items had to be entered using a separate menu option as the operations file did not hold their details. The user inputted a trade and then the system automatically assigned a free operation number to it. Standard details pertaining to the operation and the estimate details were then entered via the screen. When completed the system automatically updated the operations file with the rogue operation's standard details.

iv) When all the operations for an estimate had been entered and checked to be correct, various management reports could be produced. Estimates could be printed for the firms use or for the client with a factor applied to the operations to allow for overheads and profit. See Figures 14 and 15 for typical estimates printed for in-house use and for the client. (See Appendix 4.4. for full estimate report listings.)

v) To copy an estimate to form a new estimate was simple. The contract code for the estimate to be copied was entered along with a new unique code to identify the new estimate. The details in the new estimate could then be altered at will.

ESTIMATE FOR PROVID 1

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCH. COST	TOTALS
5	LAB	12	PREP	1.20	4.00	M.SQ	BREAK UP UNREINFORCED CONCRETE 150 THICK	15.93	0.00	0.00	0.00	15.93
6	LAB	16	PREP	5.33	0.60	M.CU	OVERSITE CONCRETE 150 THICK	10.61	17.40	0.00	0.00	28.01
7	LAB	20	PREP	0.06	4.00	M.SQ	DAMP PROOF MEMBRANE	0.79	0.08	0.00	0.00	1.67
9	LAB	21	PREP	0.60	4.00	M.SQ	ARDIT SCREED	7.96	2.00	0.00	0.00	9.96
10	LAB	44	PREP	0.40	34.00	M.SQ	STRIP OFF PLASTER FROM WALLS - SOFT	49.36	0.00	0.00	0.00	49.36
25	CARP	125	CAR2	1.00	5.00	M	PIPE BOXING TO WATER PIPES	19.55	12.25	0.00	0.00	31.80
30	CARP	124	CAR1	0.33	36.00	M	TAKE OUT WINDOW & PREPARE OPEN ING FOR NEW	46.45	0.00	0.00	0.00	46.45
31	BLR	60	CAR1	1.00	2.00	M	TAKE OUT STONE OR CONCRETE SIL L	7.82	0.00	0.00	0.00	7.82
32	BLR	91	CAR1	4.00	0.60	M.SQ	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	9.38	9.60	0.00	0.00	18.98
33	BLR	71	CAR1	1.00	2.00	M	REFIX CONCRETE OR STONE CILL	7.82	0.60	0.00	0.00	8.42
							PAGE TOTALS	233.94	75.07	16.45	2128.00	2453.47
311	LAB	68	BLKX	1.05	3.00	M.SQ	RAKE OUT JOINT & POINT STACKS	27.48	0.38	0.00	0.00	27.86
315	BLR	93	BLKX	2.90	3.00	M.SQ	ONE BRICK WALL FACED BOTH SIDE S	34.01	48.60	0.00	0.00	82.61
325	LAB	9	LABX	1.33	0.75	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	3.62	0.00	9.27	0.00	12.89
330	SUBC	2	SUBC	0.00	1.00	NO	ALL ELECTRICAL WORK	0.00	0.00	0.00	380.00	380.00
335	SUBC	3	SUBC	0.00	1.00	NO	ALL PLASTERING WORK	0.00	0.00	0.00	889.00	889.00
340	SUBC	4	SUBS	0.00	1.00	NO	ALL PAINTING WORK	0.00	0.00	0.00	610.00	610.00
							TOTALS #	1624.96	1044.37	67.78	4007.00	6744.13

Figure 14. TYPICAL FIRMS' ESTIMATE.

ESTIMATE FOR PROVID 1

REF	DESCRIPTION	QUANT	UNIT	TOTALS
5	BREAK UP UNREINFORCED CONCRETE 150 THICK	4.00	M.SQ	20.71
6	OVERSITE CONCRETE 150 THICK	0.60	M.CU	36.42
7	DAMP PROOF MEMBRANE	4.00	M.SQ	2.17
9	ARDIT SCREED	4.00	M.SQ	12.95
10	STRIP OFF PLASTER FROM WALLS - SOFT	34.00	M.SQ	64.17
36	SUPPLY ONLY SINGLE GLAZING	1.00	NO	102.02
40	FIXING WINDOWS	31.00	M	38.69
45	SUPPLY ONLY WINDOWS	1.00	NO	268.76
55	MASTIC POINTING	32.17	M	44.83
60	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS	39.00	M	49.55
65	WINDOW BOARDS ON BEARERS	6.42	M	35.09
		PAGE TOTAL £		3820.61
310	CONCRETE 300 THICK & WHEEL UP TO 30M	0.50	M.CU	31.79
311	RAKE OUT JOINT & POINT STACKS	3.80	M.SQ	36.22
315	ONE BRICK WALL FACED BOTH SIDES	3.00	M.SQ	107.40
325	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	0.75	M.CU	16.76
330	ALL ELECTRICAL WORK	1.00	NO	494.00
335	ALL PLASTERING WORK	1.00	NO	1155.70
340	ALL PAINTING WORK	1.00	NO	793.00
		TOTALS £		8767.36

Figure 15. TYPICAL CLIENTS TENDER.

6.4. TARGETTING AND PLANNING MODULE.

The targetting and planning module was written after the first stage of the estimating module had been completed. The module printed out various reports for use by management for targetting and planning purposes.

Targetting reports were produced for trades, sections of the work or for selected operations. For each target report a factor could be applied to the labour content of each operation to allow for preliminary items such as travelling time. The factor could also allow for the rate of payback given to the operative. This was related to the proportion of time saved payed back to the operative as a bonus.

Comprehensive reports could be produced for either management use or as target sheets for the operatives. Management reports gave a full list of operations, with all the estimate details. See Figure 16.

TARGET SHEETS FOR PROVID TARGET SECTION CARX

EST REF	DESCRIPTION			TARGET - HRS	
240	TAKE DOWN TIMBER GUTTER			2.11	
		6.42 M	0.33 Hours/M		2.33
245	FIX TIMBER GUTTER			4.23	
		6.42 M	0.66 Hours/M		4.66
250	OUTLET TO TIMBER GUTTER AND JOINT TO RWP			1.00	
		1.00 NO	1.00 Hours/NO		1.10
251	PVC PAINWATER PIPE			2.00	
		5.00 M	0.40 Hours/M		2.20
255	SHOE TO PVC RWP			0.25	
		1.00 NO	0.25 Hours/NO		0.27
				TOTALS	9.60
		FACTOR	1.10	FACTOR TOTAL	10.56

Figure 16. TYPICAL MANAGEMENT TARGET SHEET FOR A TARGET SECTION CARX.

The report provided the basis for calculating the duration for each operation. This enabled the contracts' managers to draw up simple programmes and to plan the work using information from the estimate. Contracts' managers could go onto site with all relevant information to hand. While on site, they could alter targets and assess progress with the knowledge that the altered targets were related to the estimate.

Target sheets were produced using the same information for operatives. However, the operatives would not need all the information given on the management report, so it was altered to print only relevant information. It gave a list of operation descriptions and a factored total of hours. See Figure 17 and Appendix 4.4. for full target report listings.

TARGET SHEETS FOR PROVID TRADE BLR 1

EST. REF.	DESCRIPTION	TARGET - HRS
285	FORM HOLE IN CAVITY WALL OR 1 BRICK WALL & BUILD IN A.G	
35	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING	
260	RAKE OUT JOINTS & POINT BRICKWORK - SOFT MORTAR	
31	TAKE OUT STONE OR CONCRETE SILL	
33	REFIX CONCRETE OR STONE SILL	
90	HALF BRICK WALL IN FILLING OPENINGS UP TO 1 SQ.M	
32	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	
301	RAKE OUT JOINT & POINT VERGE	
315	ONE BRICK WALL FACED BOTH SIDES	
	TOTALS	58

Figure 17. TYPICAL OPERATIVES TARGET SHEET FOR TRADE BRICKLAYER.

6.5. SETTING THE CRITERIA FOR MEASURING THE EFFECTIVENESS OF THE NEW SYSTEM.

The system as a whole would be considered a success if it could be used by a number of the collaborating firms to integrate their estimating, targetting and planning systems. The criteria for measuring the advantages of using the new system were set down during the initial discussions with the firm and are summarised below. (See Section 3.4.)

Produce Tenders. (See Section 3.4.1.)

i) Accuracy of standard labour outputs stored for estimating. How comprehensive was the file of standard operations?

ii) The amount of reliable feedback information obtained.

iii) Time and effort required to produce estimates.

iv) Amount of information available for use during contract management.

v) Accuracy and consistency of estimates produced throughout firm.

vi) Ease of updating of standard information particularly material prices.

Production Management. (See Section 3.4.2.)

i) Ease of extracting information from the estimate.

ii) Amount of management information available, which was directly related to the estimate, particularly planning information.

iii) Labour productivity on site was low and uncontrollable.

iv) The amount of labour costs and output feedback information obtained.

v) The amount of staff time required to administrate the control systems.

Manage Finances. (See Section 3.4.3.)

i) The speed of obtaining reliable cost control figures for use during construction.

ii) Amount of control over direct labour costs.

To quantify the improvements in terms of cost or hours saved was difficult as the detailed information required was not available. To assess any improvements, subjective comparisons were made between the old manual system and the new system for the criteria above.

6.6. EFFECTIVENESS OF NEW SYSTEM IN USE.

Produce Tenders (See Section 3.4.1.)

i) The standard operations file contained more than eighty per cent of operations in value, for typical contracts. Any less would have made the system too time consuming to use as lots of rogue operations would have to be created. Outputs were based on feedback information obtained from a small builder who had analysed labour productivity on site. The system had the flexibility to allow individual builders to alter and build up the operations file to match their own requirements.

ii) Reliable accurate feedback information could be obtained which was directly related to information held in the estimate, particularly regarding labour details and outputs for work contained in targets.

iii) A time trial to investigate how long it took to input a whole estimate was to be determined later. During testing, the preparation of estimates took slightly more time than producing them manually because of the searching for relevant operations through the database and the keying in of the operations details. Also, a large percentage of rogue items had to be input as the standard operations file was not sufficiently comprehensive at that time. Over a period of time the percentage of rogue items fell as the standard operations file grew.

However, when complete, the system saved time calculating the total costs of the estimate, which allowed the estimator to analyse the estimate using the sub totalled costs. As all the calculations were done automatically, errors caused by manual calculations decreased. Staff time was saved from not having to do any calculations or produce typed copies of estimates for in-house and clients use.

For estimating similar types of contract the system was much quicker as whole estimates could be copied and altered simply.

However, the final estimate provided better contract management information to compensate for any additional time required at the estimating stage.

iv) The ease of updating standard information used for estimating such as labour outputs was very simple and easy. The system did not have any facility for storing material prices as it was felt to be outside the scope of this project.

v) Estimates produced by different estimators would be more accurate and consistent as they were built up from a standard file of operations with outputs. The difference in measuring techniques between estimators could not be altered.

vi) Estimates were produced with an improved level of detail and accuracy and all basic estimating information was stored.

Manage Production (See Section 3.4.2.)

i) The format and structure of estimate, target and planning information was similar which made extracting and comparing information easier.

ii) If the contract was won, the management information provided was ideal for planning and controlling contracts. All management information was obtained by inputting the requirements in terms of the operations required, factor to be used and whether it was intended for management or operative use.

The system provided the time in manhours for each operation and trade, which enabled contracts' managers to calculate the durations of operations. This information could then be used to draw up simple programmes and determine schedules to help manage contracts.

iii) Targets directly related to the labour content in the estimate could be obtained for use in incentive schemes. Target reports were built up automatically, showing only the information required. Over a period of time, labour productivity should rise due to offering realistic incentives based on the estimate figures for all contracts and better overall control of labour costs.

iv) If targetting and planning information was used, feedback information obtained from the operatives target sheets could be used to ascertain whether the outputs in the operations file were reasonably accurate. The information needs to be collected over a period of time so that the variables that affect the figures can be determined, such as conditions on site, amount of work to be done and location. However, this information should be easier to obtain as both estimating and production management functions were integrated through the units of production, operations.

v) The time spent obtaining relevant production management information from the estimate was greatly reduced. The amount of re-sorting and re-calculating information related to the estimate was minimal. The amount of staff time required to obtain all management information was small as typing of reports was done automatically.

Manage Finances (See Section 3.4.3.)

i) Cost control, primarily related to labour costs was improved in terms of speed of feedback and the amount of detailed information obtained. The system should enable contractors to establish better cost control systems by using the estimate and management information as a foundation upon which contracts costs could be controlled.

6.7. POSSIBLE FUTURE DEVELOPMENTS FOR THE NEW SYSTEM.

There are a number of possible developments which would improve the system. These would be simple to implement as the data was stored in structured files (ASCII) and provided future developments structured the additional data correctly, no problems are envisaged.

It should be possible to link the new system into standard micro computer packages.

A useful development would be to produce an integrated database system in which all the data was stored in structured files. Consequently, information would be stored in the most efficient manner as redundancy has been reduced to the minimum. Any procedure could then be written using the information held in the database. Possible procedures and expansion to the database are outlined below.

Produce Tenders- It would be possible to build up database files for labour, plant, material and subcontract resources and link these to the system along with details of suppliers and sub contractors to produce an integrated estimating system. This could be extended to provide database files holding standard information about contracts, estimates and tenders completed and other such information.

Procedures could then be written to provide information for purchasing materials and sending quotes to suppliers or sub-contractors.

The sophistication of the estimating procedures could be improved to offer a more flexible approach to the input of the labour, plant, material and subcontract data.

To make the estimate more useful, it could be split into sections and management reports produced for specific sections. This would enable firms to split estimates into logical sections so providing them with more relevant information. For example, the estimate could be split into elements of the building or into separate locations.

Another useful enhancement would be a facility to combine estimates together. Estimates for standard elements of buildings could then be produced and combined as required to produce a full estimate.

Manage Production- It may be possible to link standard packages to the system to provide management reports for planning and scheduling. An integrated production management system for contracts related to estimates could then be developed.

The procedures themselves could be more sophisticated in the handling of variation orders as at the moment a new estimate has to be created representing the variation order and then comparisons made with the old estimate.

Feedback information could also be integrated into the system. Data collected on site could be input to the system and feedback reports produced. These could take the form of variance reports where estimated values are compared with those achieved.

Manage Finances- The basis of the financial system would be the estimate. Cost control and financial reports could be produced from a database designed to integrate such information with the estimate information. Standard micro computer packages could also be added to enable cost control to be achieved and variance of cost reports produced to highlight overspending in particular trades or operations. Other useful functions could be usefully integrated are interim valuations and final accounts.

CHAPTER 7.

CONCLUSIONS.

The research hypothesis stated that whilst information for estimating, targetting and planning was derived from separate sources it should be possible to integrate these activities by using standard data and database management techniques.

Initial research highlighted the traditional definition of a small firm in the construction industry was becoming inaccurate due to changes in the industries characteristics. These were mainly caused by a large increase in the use of labour-only subcontracting and the dramatic affects caused by the recession on the economic and market conditions.

The basic problems for the four collaborating firms were due to estimates not being consistent and being built up from experience with little or no feedback pertaining to outputs or costs achieved on site. Planning and targetting was usually based on general experience and not the estimate information.

7.1. SMALL BUILDING FIRMS HAVE SIMILAR LOGICAL STRUCTURES.

Structured systems analysis provided a methodology which gave clear, logical models of how firms operated. The methodology was particularly useful for producing graphical representations rather than the usual massive amount of written documentation.

When firms' physical organisation structure and management systems were analysed they were all different in virtually all aspects.

However, when the models for each case study were compared, a similar pattern emerged. Every firm carried out similar functions and activities to produce tenders and manage production. Information flows which linked the activities were similar in terms of what information was used and its sources and destinations.

It was concluded that even though small building firms have different physical characteristics, their methods for controlling the construction process all rely on similar functions and these use, store and transfer similar information in similar ways. Therefore, it was possible to draw up a standard model representing a small firms logical structure.

7.2. SMALL FIRMS MAJOR PROBLEMS WERE RELATED PREDOMINANTLY TO LABOUR COSTS.

When the firms' problems relating to estimating, targetting and planning were investigated using the structured analyses, it was confirmed that they tended to use separate sources of data for management.

The information was not co-ordinated which resulted in re-sorting and re-calculating of information. This required a lot of staff time and created problems for the firms as staff resources were usually insufficient to carry out all the necessary work. This problem was worst for controlling labour costs as material and sub contract costs were controlled by checking that the final payment was equal to the original quote, allowing for variations. Labour costs were estimated from general experience and no direct feedback from site was obtained from which some control could have been maintained.

7.3. INFORMATION WAS NOT CO-ORDINATED FOR USE IN A NUMBER OF FUNCTIONS.

The general model provided a detailed standard logical representation of small building firms. When the general model was related to the original problems, a number of conclusions were put forward.

The use of information was not co-ordinated between the functions properly. Fundamental estimating information which was required for producing plans or targets was not included in the estimate document. When the estimate was used for production management a number of suppositions had to be made to produce any useful information. To be of any value the data used throughout the functions had to be fully co-ordinated to minimise re-sorting and re-calculation.

The information used was not stored effectively, as throughout the system the same data items were stored more than once, sometimes with different values and was not classified or indexed into sub groups. This meant that whole files had to be searched to sort out relevant information, usually by laboriously searching through the file for a description or name.

A more efficient system could be designed by co-ordinating and structuring the information efficiently so that effective control and feedback procedures can be set up.

7.4. CO-ORDINATING THE NEW SYSTEM AROUND OPERATIONS.

The general model provided a suitable basis for designing the activities and information flows for the new system.

The most effective way to co-ordinate the information was to produce a standard list of production orientated operations from which estimate and management information was derived. In this way all information was obtained or derived from a single source, which enabled an accurate feedback system to be set up.

A list of standard operations was made up for use on alteration, repair and refurbishment contracts based on operations. This was discussed with the builders and it was concluded that the format was suitable for use with the proviso that the system had sufficient flexibility to allow individual firms to build up and alter the database to match their own requirements.

It was decided to store an output for each operation in terms of 'hours per unit', rather than a unit cost. When outputs had been established they would rarely need changing, unlike unit costs which would need updating regularly. The standard output was used to generate all labour information. A number of sources of information were investigated to determine the basis on which the outputs should be calculated. A statistical analysis of four price books clearly indicated that they were not accurate. Further work study data was analysed from a number of sources but to convert it into a suitable format would have been far too time consuming and would probably constitute a research project in its own right.

It was concluded that a list of operations matched to individual firms requirements could be used to co-ordinate the functions but further work was required to find a suitable source for output information.

7.4.1. STRUCTURING THE NEW SYSTEMS INFORMATION.

Database management techniques provided a logical methodology for transforming the practical requirements of the new system model into a format suitable for implementation using a micro computer with a database system.

7.5. IMPLEMENTATION OF THE NEW SYSTEM.

The strategy for developing the new system confirmed the use of structured systems analysis with data co-ordination and database management techniques to be suitable for the building industry.

The new file structure and database consisting of operation details was implemented on a micro computer to assess the success of the development techniques and the practical uses of the new system.

The computerised system allowed individual builders to;

i) Modify and build up the standard file of operations and outputs to suit their own requirements.

ii) Build up an estimate made up of standard and rogue operations. Each operation in the estimate had details of unit rates for labour, plant and material and a subcontract sum. A unique labour output and target section could be applied to each operation.

iii) Produce similar estimates very quickly as estimates could be copied from a previous similar one.

iv) Produce fully priced estimates for the firms own use.

v) Produce estimates for clients with a percentage markup for overheads and profit.

vi) Access planning and targetting information for management or operatives based on;

a) The whole project.

b) A whole trade.

c) Target sections as set up for each contract.

d) An ad hoc collection of operations.

7.6. BENEFITS OF THE NEW SYSTEM IN USE.

The practical benefits to small firms were many and varied. Initially the production of estimates would take slightly longer than usual as the operations file would need altering to match their requirements. Also the estimator would not be fully conversant with the systems characteristics. However, it was envisaged that after a short period of time the system would save firms time and produce more accurate, relevant information.

When initially tested the database included over eighty per cent of operations in number and value for refurbishment and alteration contracts. As the database expands through the inclusion of rogue items this proportion will increase. The system automatically calculated the costs of each operation and total costs and produced copies suitable for the firm and client. Similar estimates were much quicker to produce as the information was already stored and only details had to be changed.

In the opinion of the participating firms, the time taken to prepare estimates was approximately the same time as before, but they were more accurate and there were no arithmetic errors. In addition the system provided much relevant management information automatically which was one of the objectives of the research. (Oxley and Westgate:1985)

Management reports were produced in an ideal format for targetting and planning related to the estimate document. The system achieved the main aim of the project, to set up an integrated estimating, targetting and planning system based on a standard set of data.

Another advantage was that clerical staff time was saved due to the automatic calculating of estimates and targets and the automatic printing of estimates and reports.

The system would enable small building firms to improve the control of labour outputs and costs, provide incentives to operatives, obtain feedback information more quickly and more accurately and enable staff to carry out more complete analyses of work in terms of cost and output. This goes a long way in reaching the builders objectives for the system. The system itself proves the validity of the hypothesis that one source of data can be used to produce estimates which can then be used to create related management reports if the data is structured correctly.

7.7. RESEARCH RECOMENDATIONS.

Overall, the design of the system confirms the validity of the hypothesis that estimating, targetting and planning could be integrated using standard data and database management techniques.

The major limitation of the system was the lack of sophistication when estimating. This was due to restrictions placed on users by the software written, which was a reflection of the shortage of development time rather than an inherent weakness in the hypothesis. Future versions of the system could be written which allowed greater flexibility and sophistication for estimating, targetting and planning and related functions. To gain the full advantage of these additions thorough research would be required to establish whether the extra functions were worthwhile and the best method of implementation. See Section 6.7.

Through the general success with the development and practical use of the new system, a number of possible enhancements and future developments were identified as follows;

i) Production of a more sophisticated and flexible system which would allow firms to match the system to their operating requirements.

ii) Provision of accurate labour output information for inclusion in the standard operations file.

iii) Provision for integrating the system with related contract management functions. The most productive extension would be to integrate the planning of a number contracts as all the information required is now stored on file.

If a targetting system was in use, target data received from site could be keyed in to produce reports of outputs achieved, total costs and savings.

Other functions which could be added include interim valuations and final accounts to improve cost control.

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APPENDICES.

CONTENTS. PAGE.

APPENDIX 1.

1.1. INITIAL STUDY OF A.

1.1.1. HISTORY OF A.

A was formed in 1916 as a small property repairing business. From 1916 to 1957 it developed into major property repairers and renovators of houses. In 1957 it became a limited company and started to diversify into general contracting as the size of the renovations market decreased. It steadily grew until 1970 and since then has not changed. The majority of their work was in repairs, small works and general building contracts upto £1 million, with an annual turnover of £2 million. Specification and drawing contracts amount to approximately 50% of the total turnover.

1.1.2. ORGANISATION AND MANAGEMENT STRUCTURE OF A.

The organisation was headed by a chairman and three directors who each control separate departments, estimating and surveying, production management and finances.

The financial director was responsible for all financial forecasting and control of the company finances. He was helped by an assistant and two clerks.

The estimating and quantity surveying director was responsible for producing the tenders and handling the surveying for each job, with the help of an assistant surveyor. See Figure A1.1.

The work tendered for was divided into three sections;-

small contracts for jobbing, maintenance and small contracts; large contracts for large or complex jobs and PSA work for government funded work.

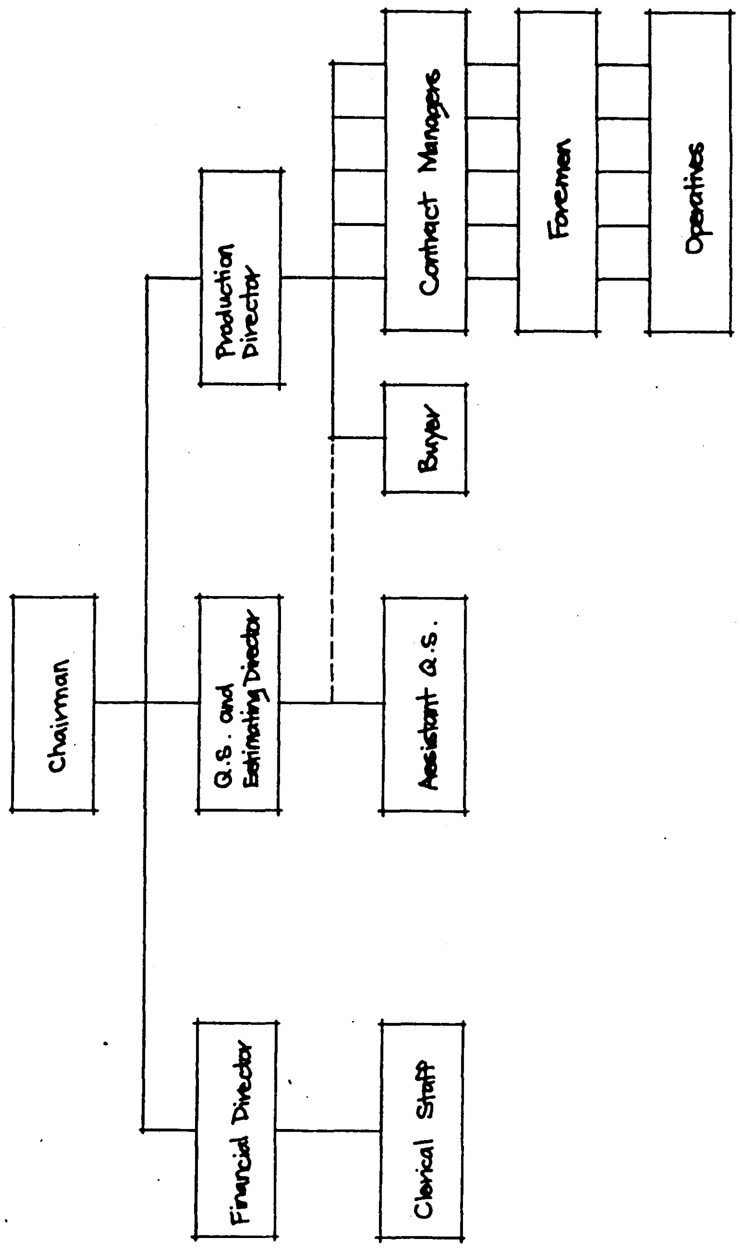


Figure A1.1. ORGANISATION STRUCTURE FOR 'A'.

If the estimator needed quotes for items of plant, material or sub-contractors he gave the buyer all the information who obtained the keenest quotes and prices.

If the workload for taking off and estimating was high the financial director helped out.

Once the estimate had been finalised and a total calculated, the estimating and financial directors would check and finalise the estimate to see that everything had been priced for and a reasonable rate of return could be expected.

The production director was responsible for the management and profitability of jobs after the tenders had been produced. He supervised the work of six contract managers who handled the day to day running of the contracts and the buyer made out orders for any materials, plant and sub contractors items needed.

Once a tender had been accepted, all the tender and contract information was handed to the production director. He allocated the job to a contracts manager and then they informally sorted out a basic method and plan of construction. The contract manager was responsible for the management of the contracts so that they finished on time and within budget.

The larger sites were run by foremen who organised the labour and materials.

Measurement of the work on site along with all the surveying was the responsibility of the estimating and surveying director.

1.2. STRUCTURED ANALYSIS OF A's MAJOR FUNCTIONS.

See Figure A1.2 Function Matrix and Figure A1.3. Information Flow Diagrams.

Figure A1.2. Function Matrix Diagram For A.

RESPONSIBILITY / FUNCTION	CHR MAN	FIN DIR	EST .QS DIR	ASS QS	PRD DIR	CON MAN	BUYER
BUILDING.	X	X	X		X		
FINANCIAL ACCOUNTING AND MANAGEMENT		X					
Job costing and accounts.		X					
Financial forecasting.		X					
Financial control		X					
PRODUCE TENDERS.		x	X	X			
Administrate enquiries.	X	X	X		x		
Take off			X	X			
Obtain quotes.			x				X
Build up rates.			X	X			
Complete and check tender.		x	X	X			
Complete and check estimate.			X	X			
PRODUCTION MANAGEMENT					X	X	
Plan and organise work.					X	X	
Calculate incentives			x		X		
Manage labour.					X	X	
Manage sub-contractors.					X	X	
Buying plant and materials.					X		X
Surveying.			X	X			
Progress reporting.		X	X		X	X	x

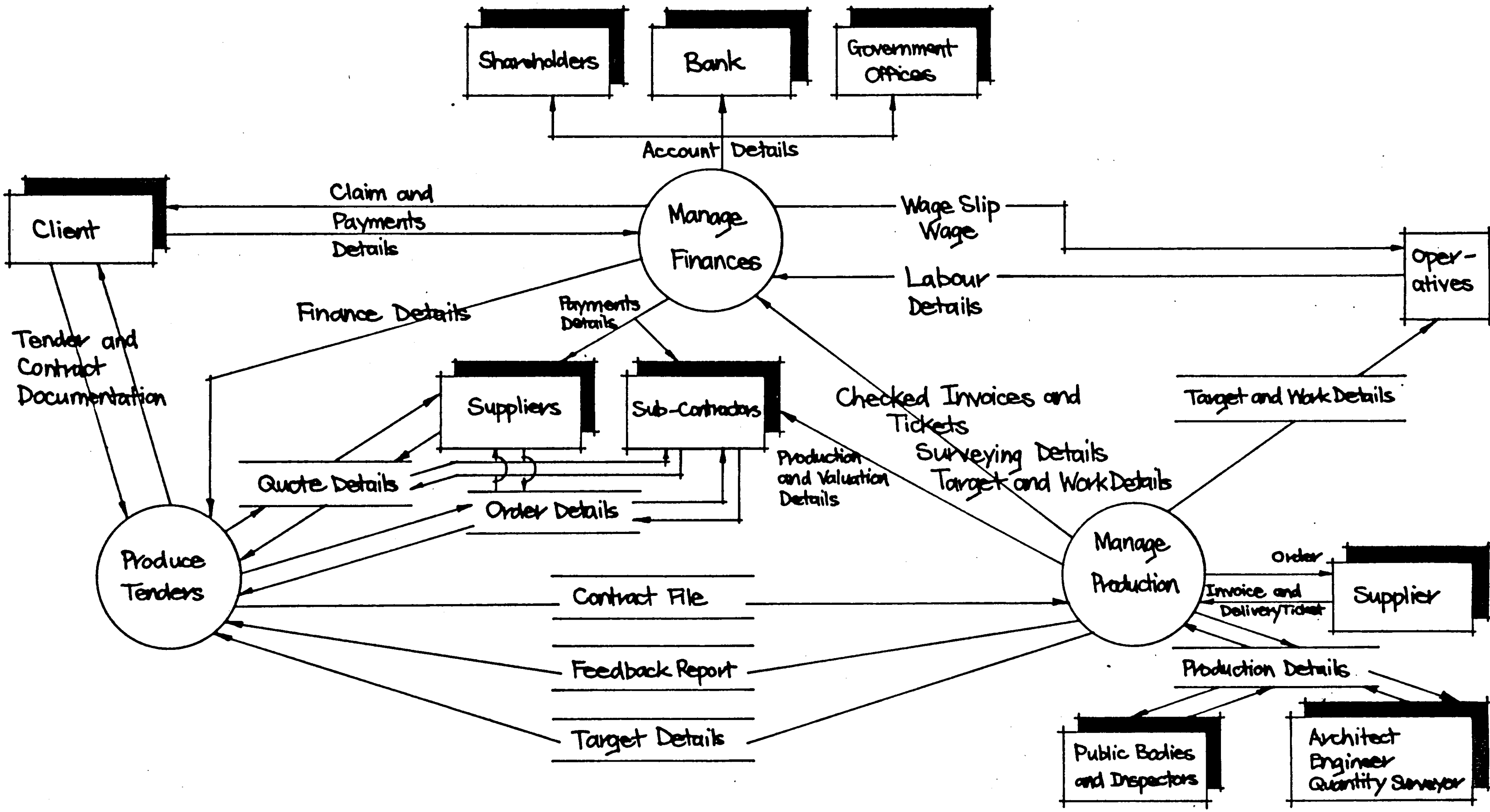


Figure A1.3.0. CONTEXT DIAGRAM FOR 'A'.

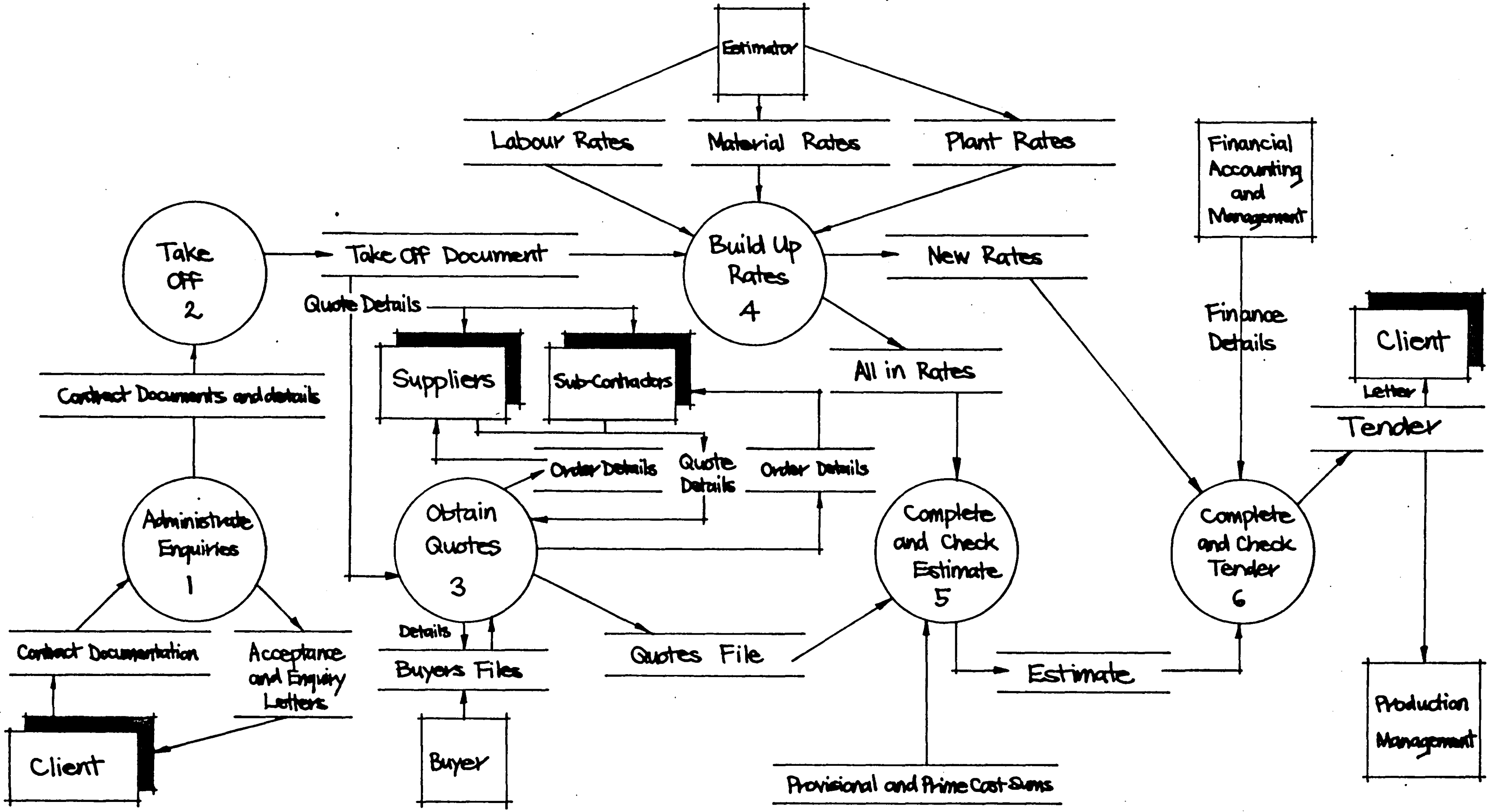


Figure A1.3.1. PRODUCE TENDERS FUNCTION.

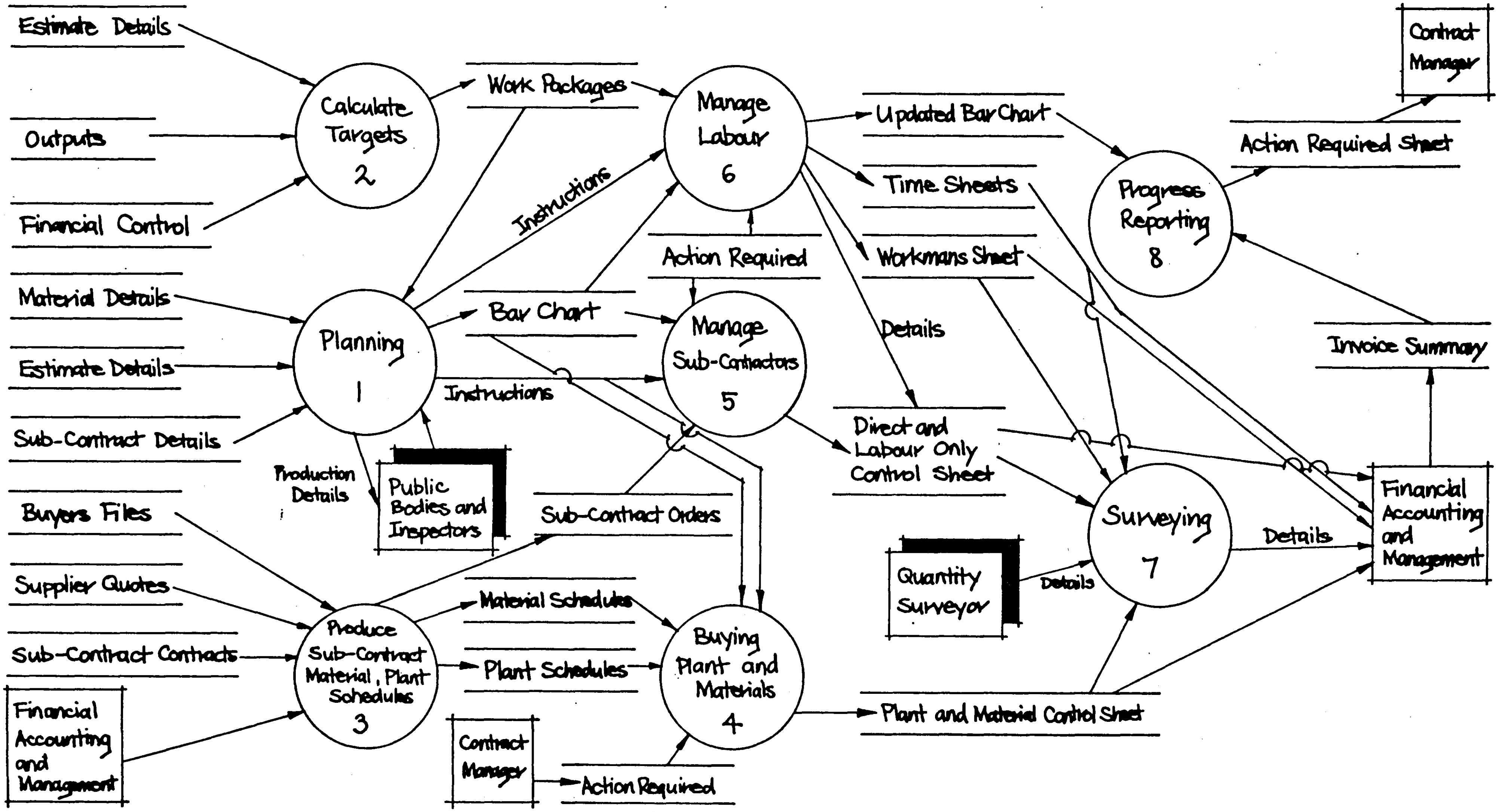


Figure A1.3.2. PRODUCTION MANAGEMENT FUNCTION.

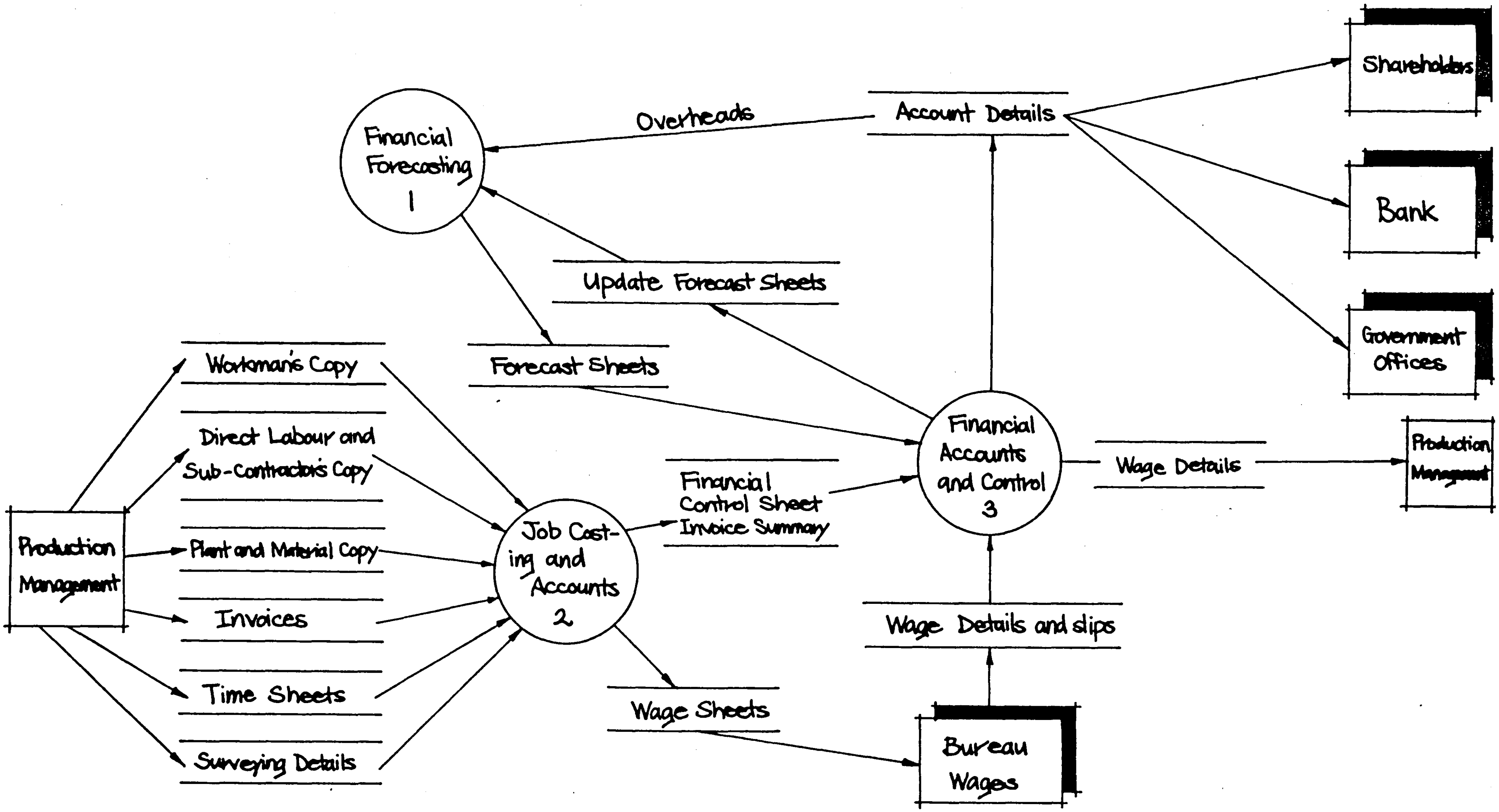


Figure A1.3.3. MANAGE FINANCES FUNCTION.

PRODUCE TENDERS.

1. Administate Enquiries.

The financial and estimating directors made the decisions about what work to tender for and which prospective tender lists to be put on.

2. Take Off.

If the job was based on a specification and drawing, the work items were measured and an estimate document prepared. The work was taken off in terms of operations, loosely linked to SMM6, which were grouped together by trade and arranged in the rough order of construction. See Figure A1.4.

3. Obtain Quotes.

While working through an estimate the estimator required quotes for prices for the supply of plant, materials or sub contractors to do the work. The estimator collated all the information needed for separate quotes and gave this to the buyer whose responsibility it was to get the keenest possible prices. If prices or quotes were not received quickly enough, the estimator put in his own figure, until the quotes were received.

1.Build Up Rates.

Unit rates were built up from labour, plant, material and sub contract costs and quotes by the estimator using his general experience.

5.Complete And Check Estimate.

For large contract work the estimate was priced net with the margin added at the end, but small contract work was priced gross with the margin included in the labour rate.

For all contracts, the estimate was checked to see that everything had been priced for, and the rates were correct. Any rates or quotes that seemed high were checked and altered, or re-submitted if necessary. See Figure A1.4.

6.Complete And Check Tender.

Margins for work were subjectively set by the estimating and financial directors taking into account the work type, competition, market conditions and the present financial state of the firm, worked out from the financial forecast sheets. If a tender was negotiated or an estimate figure was to be reduced the financial director would become involved in identifying possible items and rates that could be reduced.

Provision for new toilet facilities
& Alterations to Kitchen

To

"The " Public House

for

& Co. Ltd.

At

Street, Sheffield

FIGURE A1.4. TAKE OFF AND ESTIMATE DOCUMENT

FOR 'A'.

			corrugated asbestos cement roofing sheets over lean to structure, cart away to tip	11		
4.32						
2.55	11.02					
			9/1.			
			Remove lintol over existing double doors to yard entrance + cart away		Item	
			Demolish the existing s/c frame to the lean to structure + cart away to tip.		Item	
			Raylors £28/wk + 102. 30.80 ×14 wks. + erection + dismantle. + del cons. Say £550. 431.20			
			Provide + fix for duration of contract 2 no. approved type temporary toilet cubicles in moulded plastic 1.20 sq x 220 high approx, with door, washbasin w/c. Include for connecting drain to the temp manhole existing in the yard, for temp lighting in each cubicle + sign writing, ladies + gents to each door. Remove toilets + drains on completion. Also for plumbing cubicles up.		Item	
			9/2.			
			Demolish existing toilet block + remove from site all waste inc. 6.40 x ave 2.55 m 1bt brick walls 2.90 x ave 2.55 m ½bt brick walls 3.50 x 2.40 m of mono pitch roof construction covered with clay pantiles All sanitary fittings existing and for the disconnection of same + plumbing + making good upon completion.		Item	
			9/3			

FIGURE A1.4. TAKE OFF AND ESTIMATE DOCUMENT FOR 'A'.

Timesing	Dimensions	Squaring	Description	Quantity	Unit
	1.50	4.20			
			Remove from site, care, a.b.d.	4	m³
	1.50 8.40	0.20	Break up, take up & remove from site founds to exist. toilet block & backfill with selected fill. trenches left open	10	m
			9/3		
	5.10		Grub out & remove from site existing drains to toilet area 100mm ∅ & backfill with selected fill. trenches left open.	5	m
	8.89 4.32	38.40	Break up & take up all paving, natural stone or concrete, a paving path must be maintained to the toilets at all times throughout the job.	36	m²
	4.50 0.60	2.70			
		35.70	10/4		

FIGURE A1.4. TAKE OFF AND ESTIMATE DOCUMENT FOR 'A'

Timesing	Dimensions	Squaring	Description	Quantity	Unit
3/	5.80 1.00 0.60	10.44	Excavate to remove existing drains to yard to boundary wall ave 1m dp.	12	m³
	2.50 1.00 0.60	1.50	Backfill with material previously excavated.	12	m³
		11.94			

PRODUCTION MANAGEMENT.

1.Planning

Little formal planning was done. When it was done, a simple bar chart showing the major trades and sub-contractors was drawn. If targets were calculated for a contract a weekly bar chart was given to the operatives outlining their work and targets for the next two weeks. See Figure A1.5. Short Term Planning and Targetting Document.

2.Calculate Targets.

Targets were only calculated for a few contracts, usually by the finance director as the contract managers and production directors did not have time.

Target hours for work packages were calculated from the net labour rates used in the estimate. The work packages were based on separate trades or of logically grouped operations. See Figure A1.6. Targetting Documents.

3. Produce Sub-Contractors, Material, Plant Schedules.

The contract managers ordered materials and plant, by giving the buyer a requisition order stating details of the material and plant needed and the required delivery date.

1. Buying Plant And Materials.

From this requisition the buyer obtained competitive quotes which satisfied the delivery requirements, and made out an order for the material to the supplier or hirer who submitted the best quote. Usually the contract managers gave the buyer the drawing and asked him to take-off the materials required and obtain orders for a particular date to save themselves work.

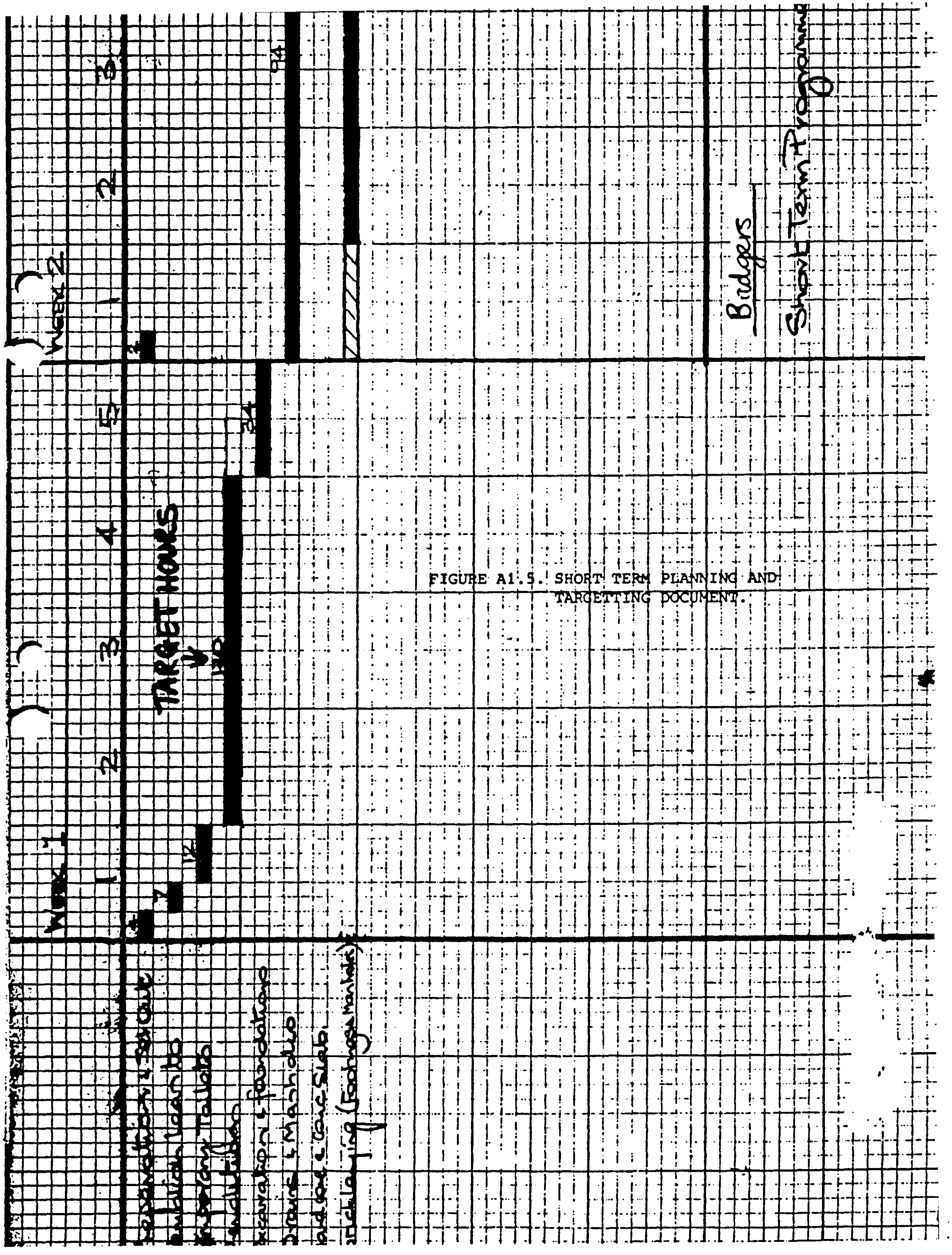


FIGURE A1.5. SHORT TERM PLANNING AND TARGETTING DOCUMENT.

Concrete area.

	Amount	hrs	Total
	52-80 / 107-50 / 57-20		
Attend to surface of hardcore, blind and level to ensure no loss of concrete	1250m^2	0.11	137
Concrete bed 225thick with fine tamped finish laid to falls including all necessary formwork and construction joints and expansion joints	1250m^2	0.70	875.0
	25-00 / 336-00 / 414-00		
	123 20 / 76-80		
A252 mesh fabric reinforcement	2500m^2	0.08	200.0
Formwork 225mm high	20m.	inc.	
			1212.5

Sleeper Fence.

	Amount	hrs	Total
Square up hole approx 1.00x1.00 x 0.55mm after JCB to receive concrete.	41N°	1.35	55.3
			85-00
Formwork to foundation, 0.45high	41N°	5.00	205.0
Plumb, line and level steel stanchion, 4m long	41N°	4.50	184.5
	84-50		
Prepare, undercoat and gloss paint steel surface	181m^2	1.50	271.5
Cut and fit timber sleepers including selecting and lodging in position.	656N°	1.50	984.0
	300 / 100 / 334		

Square up hole approx 1.00x1.00 x 0.55mm after JCB to receive concrete.	41 No	1.35	55.35
Formwork to foundation, 0.45 high	41 No	5.00	205.00
Plumb, line and level steel stanchion, 4m long	41 No	4.50	184.50
Prepare, undercoat and gloss paint steel surface	181 m^2	1.50	271.50
Cut and fit timber sleepers including selecting and ledging in position.	656 No	1.50	984.00
Concrete in Column bases and expansion joint thereto	41 No	3.25	133.25
			1833.60

FIGURE A1.6. TARGETTING CALCULATIONS.

5. Manage Sub-Contractors AND 6. Manage Labour.

All day to day management of the contracts was done by the contract managers with co-ordination coming from the production director. Administration of all contract costs was by three sheets:

1.Workmans Sheet. See Figure A1.7.

Completed by the contracts manager on small jobbing contracts, to outline the description of the job to the operative. The operative would enter in the details of his hours worked and materials used.

2.Plant and Material Sheet. See Figure A1.8.

All invoices were vetted by the buyer and surveyor to make sure that the details were correct, and allocated to the correct job. These were passed onto the clerical staff who filled in a plant and material sheet for every job.

3. Direct Labour and Sub-Contractors Sheet. See Figure A1.9.

All the labour that had been used on a job was noted down on this sheet, under its correct category. All direct labour information was entered from the time sheets handed in by the operatives, the details of which were checked by the contracts manager.

Order No. .... Date .... **Workman's Copy**

Job No.

Commenced..........

Finished..........

DESCRIPTION OF JOB

Customer's Name

Address

Work at

DATE	TIME				DATE	MATERIALS
	NAME	TRADE	HOURS	EXPENSES		
	HAULAGE					

FIGURE A1.7. WORKMANS SHEET.

Order No. .... Date ....

Plant & Materials

Job No.

Commenced ....

Finished ....

DESCRIPTION OF JOB

Customer's Name
Address
Work at

QTY.	DESCRIPTION	SUPPLIER/REF.	£ : p	DATE	QTY.	DESCRIPTION	SUPPLIER/REF.

FIGURE A1.8. PLANT AND MATERIALS SHEET.

Order No.................................Date..

Direct Labour & Subcontractors

Job No.

DESCRIPTION OF JOB

Commenced..............

Finished..................

Customer's Name
Address
Work at

LABOUR 'ONLY SUBCONTRACTOR				DIRECT/NOMINATED SUBCONTRACTOR			
NAME	TRADE	CERT No.	£ : p	DATE	NAME	TRADE	CER No

FIGURE A1.9. DIRECT LABOUR AND SUB CONTRACTORS SHEET.

Gross Claim		
Adjustment		
Actual Claim Value		

COST

LABOUR Direct

T. .... hrs @		
L. .... hrs @		
Y. .... hrs @		
H. .... hrs @		
H. .... hrs @		
Expenses		
Bonus		
Labour only Sub Contractor		
Percentage Addition .... %		

Direct/Nominated Sub Contractors

1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
+ %		

MATERIALS

+ %		

PLANT

1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
+ %		

PRELIMINARIES

REMARKS (P.T.O.)

TOTAL COST AT (V.D. ....)

FIGURE A1.10. FINANCIAL CONTROL SHEET.

7. Surveying.

The three control sheets were used to control and check costs on site and the information was used to manage finances. The surveyor used these three sheets to validate and complete claims, dayworks and extras. Details were sent to the clients surveyor and the accounts staff. The surveyor did all the measurement for each job and completed all the work necessary for valuations, payments and claims, to sub-contractors and the client.

To control the finances of the contracts the surveyor made out a financial control sheet. The surveyor completed these sheets monthly, for each large contract, and one for all the small contract work. It summarised the information entered on the three administrative control sheets by the surveyor for contract accounting and controlling the costs on site. See Figure A1.10.

8. Progress Reporting.

To help co-ordinate all the work carried out a progress report meeting attended by the directors and contracts' managers was held every Friday. The purpose of this meeting was to co-ordinate the firms resources and solve any problems. At the end of the meeting a summarised action required sheet was produced which outlined the problems and who was responsible to act on them.

MANAGE FINANCES.

1. Financial Forecasting.

Before the start of each financial year, a financial forecast broken down into months was calculated. The total overheads for the next year were calculated from the previous years accounting details. In order to cover these fixed costs, the total amount of work needed to be completed was calculated.

For each month of the year, the amount of work needed from each small and large contract and PSA (Property Service Agency) work category to cover the overheads was calculated, and to this the profit margins that were required were added. This information was summarised on forecast sheets which were updated monthly and these totals were collated over a number of years. Comparisons were made between the present and previous years performances in terms of turnover and margins for different work categories.

From the information included in these forecast sheets, the financial director had good financial control over the present workload, capital flowing through the firm and the margins being obtained.

2. Job Costing and Accounts.

To update the forecast sheets, an invoice summary book was kept running on a monthly basis. This outlined basic costs and margins obtained on individual contracts for the month, and these totals were compared with those on the forecast sheets.

The information for the invoice summary book was gleaned from the job costing information. On all jobs, a financial control sheet was completed monthly by the surveyor, from the three job control sheets which quantify all the materials, plant and labour used on a contract. See Figure A1.11.

Wages were calculated by a bureau service. Time sheets were handed in weekly by operatives giving details of where they had worked, for how long and what they were doing. The contract managers checked the details and put a contract number against each labour item. See Figure A1.12. The cost of the labour was allocated to each job, on the financial control sheet, and the details sent off to the bureau on a wages sheet. See Figure A1.13. The details were sent back along with the standard wage slips to the firm. See Figure A1.14.

The labour cost details were used for calculating day work or extras and submitting claims on them.

3. Financial Accounts And Control.

The general accounts were made up by the finance director with the help of clerks. Control of the finances of the company and separate contracts were made monthly by analysing and comparing the forecast sheets, financial control sheet, invoice summary and the three job control sheets.

[illegible]	[illegible]	[illegible]
C1189	Distington Eng	Civil Works Upgrading "X" Furnace
D1162	G. Burton	Repairs to roof, rear door etc
D1188	Coca Cola	Attend to Wall at Coleford Rd
D1191	CWS	Pump Out Vehicle Pit
D1152	David Shottlt	Repair to Shower
D1171	Home Farm Trust	Roof leak at The Elms, Dore.
D979	Mr Hunter	Credit Note
D1035	G. L. Lord	Bedroom Units & Doors
D1080	Dr Mikom	11 Hoober Ave – Pointing to Garage
D1187	Nat West Bank	Tinsley Branch – refix W.C. seat
D1181	Mr Parker	Unblock fallpipe at Kenwood Rd
D1044	Search	Repairs to door
D1170	S.H.&S.	Attend to drains & renew WC seat
D937	H. Turner & Son	Alter slope of roof & refelt
D937	H. Turner & Son	Repair roof over Dhuyers door
D937	H Turner & Son	Clean out all gutters
C1058	Norman Tate	Door & Frame at Ickles
D1195	T.W. Ward	Reglaze 24 No Panes at Albion
D1183	T.W. Ward	Supply Ply for M1 Project
C1154	Westerall Holdings	Replace damaged sheets at Viners
D1023	Mrs Woods	57 St Thomas Rd – Joinery & Plumbing
D1168	Mr Waterall	Adjust door & Pipe Clip – Froggatt
		Month 2 July 19
		Total of Previous Months

FIGURE A1.11. INVOICE SUMMARY SHEET.

MONDAY	FAIRCLOUGHS BLACKBURN MEADOWS	1381. 24	BRICKLAYING.	445	8
TUESDAY	TOMMY BANKS (HOME)	1448.	BRICKLAYING.	8.0 445	8
	WORKSOP. C1217.	96 1217	BRICKLAYING.	830 445	8½
THURSDAY	WORKSOP. C1217	96	BRICKLAYING.	7.30 445	8½
	WORKSOP C1217	96	BRICKLAYING	7.30 3.45	7½
SATURDAY	WORKSOP C1217	96	BRICKLAYING 7 3½	7.30 3.45	10½ ½
			46 35 13.45 50 TM 3.96 24 TA	TOTAL	1.05

FIGURE A1.12. TIME SHEET FROM OPERATIVE.

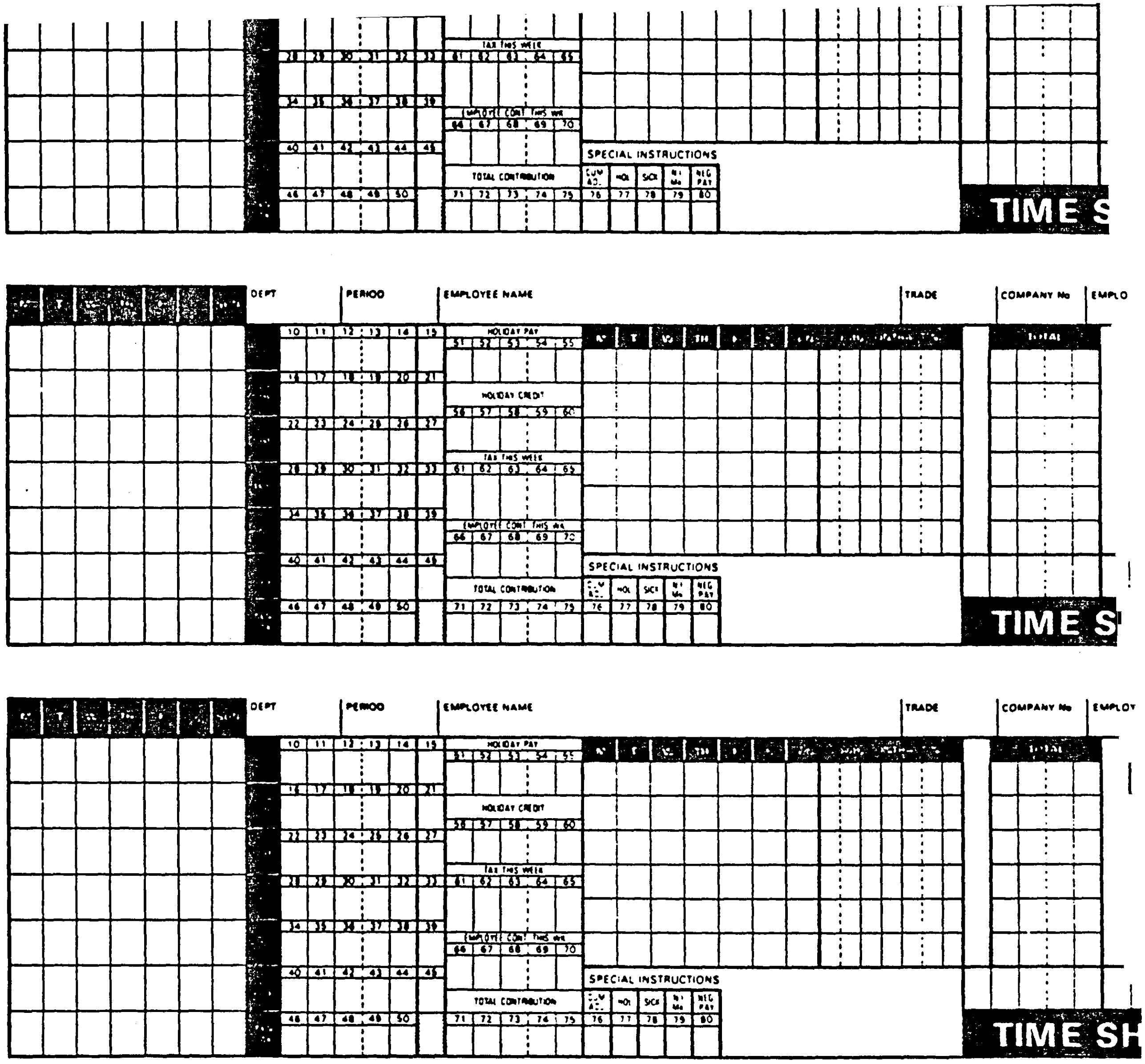
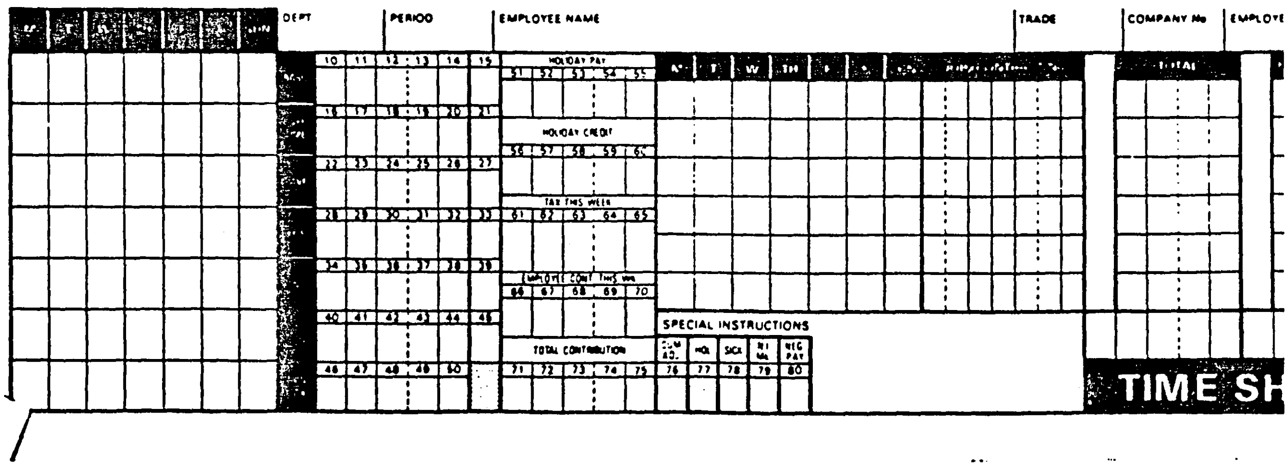


FIGURE A1.13. WAGE SHEET TO BUREAU.



PAY ADVICE

COMPANY		DEPT	PERIOD ENDING		NATIONAL INSURANCE	CODES				EMP
NAME	NUMBER		No	DATE	NUMBER	N I	TAX	OCC	PEN	NAME

MEMORANDA STATUTORY SICK PAY			A	B	C	D	E	F	SICK PAY	HOLIDAY PAY	MISC. A
PERIOD	DAYS SICK CUMULATIVE	HOURS									
PAY	SICK PAY CUMULATIVE	RATE									
		PAY									

HOLIDAY CREDIT		DEDUCTIONS THIS PERIOD												
PERIOD	CUMULATIVE	N I	INCOME TAX	COMP PENS	P	Q	R	S	T	U	V	W	X

NATIONAL INSURANCE		DEDUCTIONS TO DATE										GROSS TAXABLE PAY TO DATE	NET PAY THIS PERIOD
PERIOD	TOTAL CUMULATIVE	N I	INCOME TAX	COMP PENS.	P	Q	R	S	T	U-Y			
PERIOD	C/OUT CUMULATIVE												

PAY ADVICE

COMPANY		DEPT	PERIOD ENDING		NATIONAL INSURANCE	CODES				EMP
NAME	NUMBER		No	DATE	NUMBER	N I	TAX	OCC	PEN	NAME

MEMORANDA STATUTORY SICK PAY			A	B	C	D	E	F	SICK PAY	HOLIDAY PAY	MISC. A
PERIOD	DAYS SICK CUMULATIVE	HOURS									
PAY	SICK PAY CUMULATIVE	RATE									
		PAY									

HOLIDAY CREDIT		DEDUCTIONS THIS PERIOD												
PERIOD	CUMULATIVE	N I	INCOME TAX	COMP PENS	P	Q	R	S	T	U	V	W	X

NATIONAL INSURANCE		DEDUCTIONS TO DATE										GROSS TAXABLE PAY TO DATE	NET PAY THIS PERIOD
PERIOD	TOTAL CUMULATIVE	N I	INCOME TAX	COMP PENS.	P	Q	R	S	T	U Y			
PERIOD	C/OUT CUMULATIVE												

FIGURE A1.14. WAGE SHEET FOR FIRM AND OPERATIVE.

1.3. PROBLEMS WITH A's SYSTEMS.

PRODUCE TENDERS.

The information in the estimate was in a format which made it possible to work out bar charts and targets related to the estimated rates for operations. This tended to be a laborious process as the operations in the estimate had to be sorted into logical work packages for targets and the target in terms of hours calculated. This was very infrequently done as the firm did not have the staff available.

The information on which the rates were based, came from memory and general experience of rates used before. Outputs for different operations were based on subjective analysis of the work and reference to price books such as Spon's. The information used to produce the estimate was founded on subjective opinions. As no feedback was gained from actual production on site the effectiveness of the incentive scheme was not as good as it could be since inaccurate targets and low outputs were not identified.

Although cost control for the overall job was achieved, and the margins obtained from different work types known, this information was only obtained at the end of the contract. The accuracy of costs and outputs could not be checked down to operations level due to the work that was involved in sorting the job costing information and allocating it to the operations in the estimate. If this could be done there would be a good indication of the accuracy of the rates which would increase the accuracy of estimates.

PRODUCTION MANAGEMENT.

Bar charts and targets were not produced for most jobs because the production director and contract managers were too busy managing jobs.

If every job was planned and targets calculated, a number of problems could be solved. The co-ordination of the firms contracts could be brought together leading to an increase in efficiency of production. The estimator would get feedback on his rates from the targets set and achieved on site. Productivity would only increase here if the new targets took into account the firms present outputs. Otherwise, old inefficiencies would be carried forward into the incentive scheme and operatives would get targets set on inefficient output rates.

Presently, the operatives bonus equals all the hours they have saved multiplied by their basic rate. There were two factors not allowed for here. The scheme cost extra in overheads to run, and no allowance was made for inaccurate targets or unpredictable site conditions.

FINANCIAL ACCOUNTS.

It was very hard to get an accurate indication of the financial position of a contract mid way through the its construction. This was because the three job control sheets and financial control did not have all the costs included because of the time delay in receiving invoices from material and plant suppliers and subcontractors. This meant that accurate, upto date cost control of operations was impossible to achieve, using this method. The financial director had looked into ways of obtaining this information, but the effort required was too great.

1.4. INITIAL ANALYSIS OF B.

1.4.1. HISTORY OF B.

B was formed in 1976 as a sole trading firm by its two present directors and in 1982 it registered as a limited company. It was based in South Yorkshire where the majority of its work was in property repairs, maintenance contracts, specification and drawing and some civil engineering contracts. Its turnover was approximately £900,000 with contract values ranging from a few pounds upto £80,000.

1.4.2. ORGANISATION AND MANAGEMENT STRUCTURE OF B.

The firm was run by two directors, one managed the contracts while the other submitted the tenders and helped out with the contracts management. To help them they had a quantity surveyor who did all the surveying for the contracts, ran the bonus scheme for the maintenance contracts and helped supervise some of them. On large contracts site foremen were used to organise the labour and materials. See Figure A1.15. The amount of documentation produced for estimating and controlling jobs depended on its size and complexity. Large contracts had formal and detailed control systems, while for small contracts these became cruder and less detailed which meant less administrative work and costs. Clerical staff carried out the general administration and accounts of the firm. Accounts and job costing were run on a micro computer.

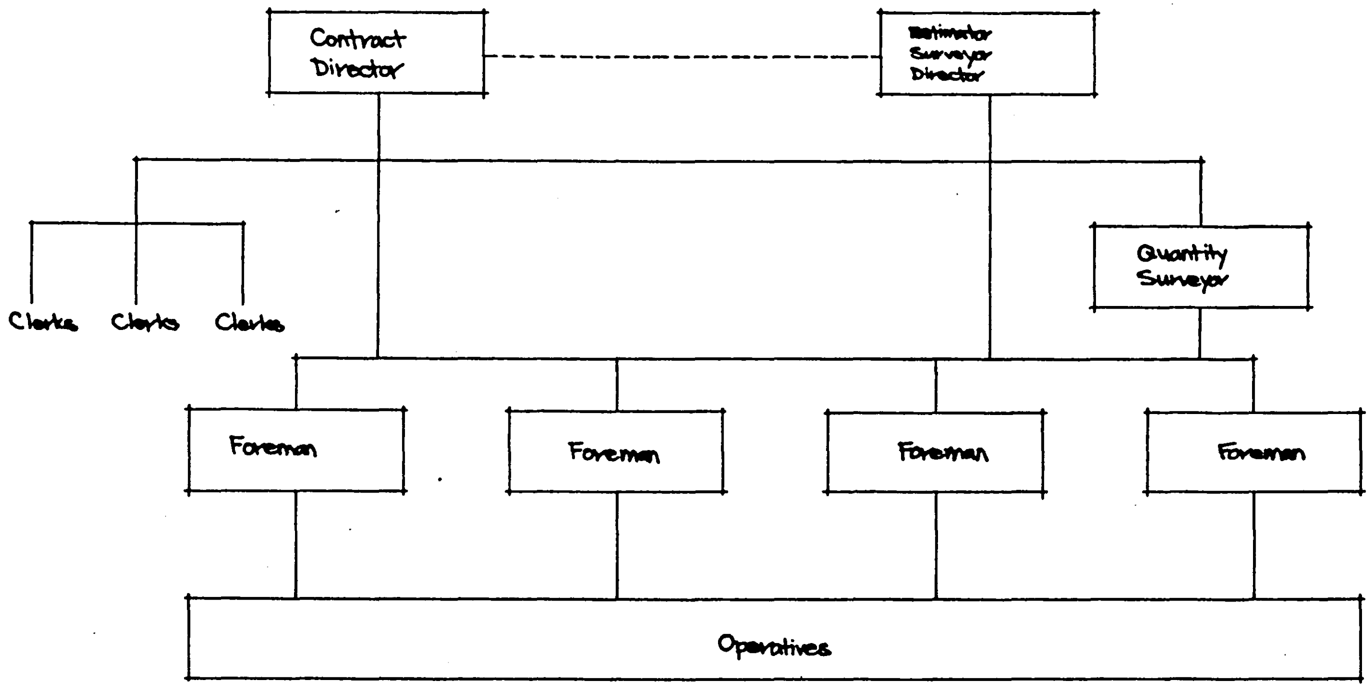


Figure A1.15. ORGANISATION STRUCTURE FOR 'B'.

1.5. STRUCTURED ANALYSIS OF B's MAJOR FUNCTIONS.

See Figure A1.16 Function Matrix Diagram and Figure A1.17 Information Flow Diagrams.

Figure A1.16. Function Matrix Diagram For B.

RESPONSIBILITY / FUNCTION	CON MAN DIR	EST QS. DIR	QS	FOR MAN	CLERK
BUILDING.	X	X			
MANAGE FINANCES	X	X			
General accountings.	x	x	x		X
PRODUCE TENDERS.	x	X			
Administrate enquiries.		X			
Take-off.	x	X			
Obtain quotes.		X			
Build up rates.	x	X	x		
Build up estimate.	x	X			
Complete and check estimate.		X		X	
MANAGE PRODUCTION	X	X	x		
Plan and organise work.	X	x	x	x	
Calculate incentives	X	x	X		
Manage labour.	X	x	x	x	
Manage sub-contractors.	X	x			
Manage material and plant supply.	X	x		x	
Administrate surveying.	X	x	X		

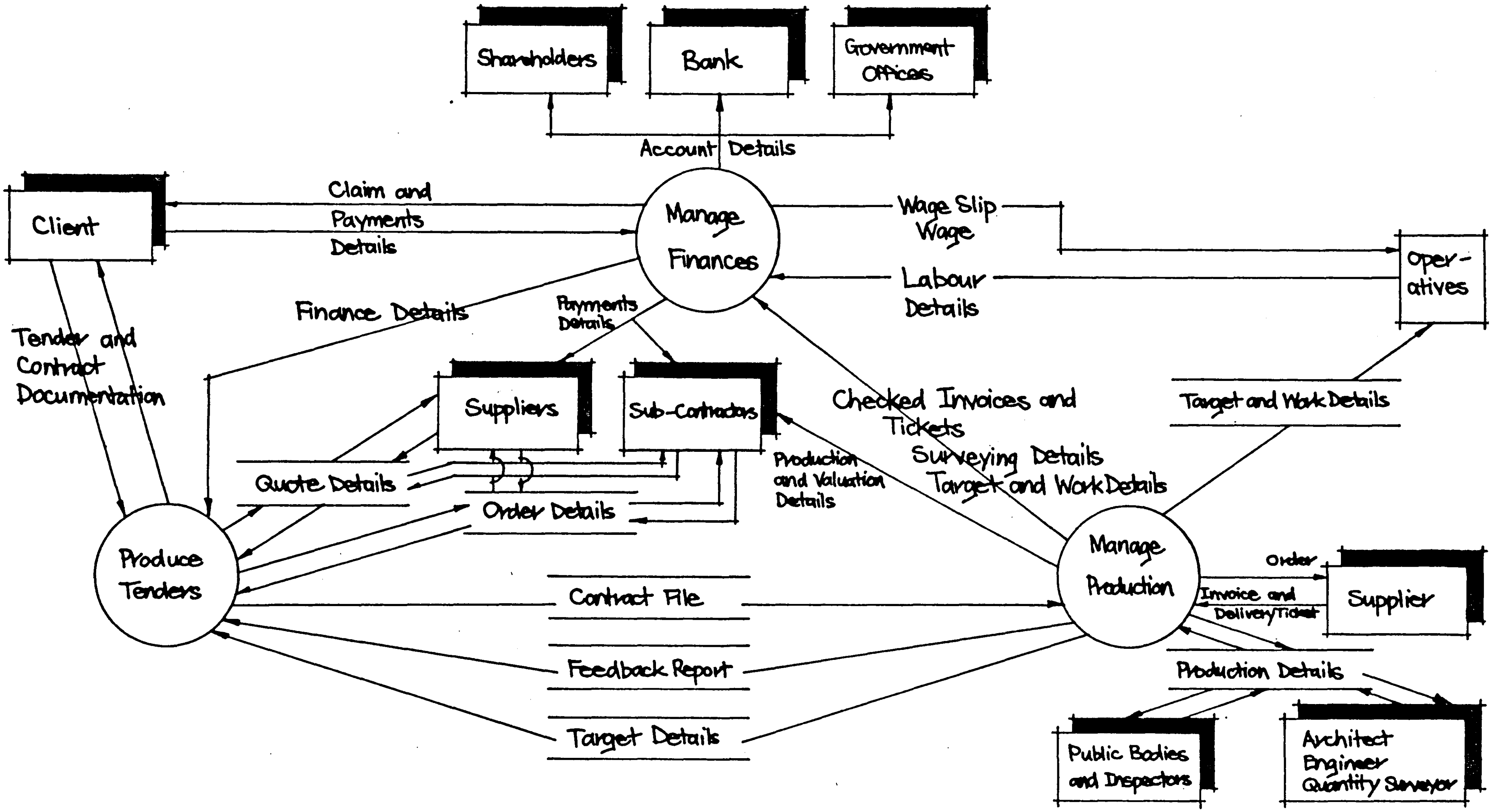
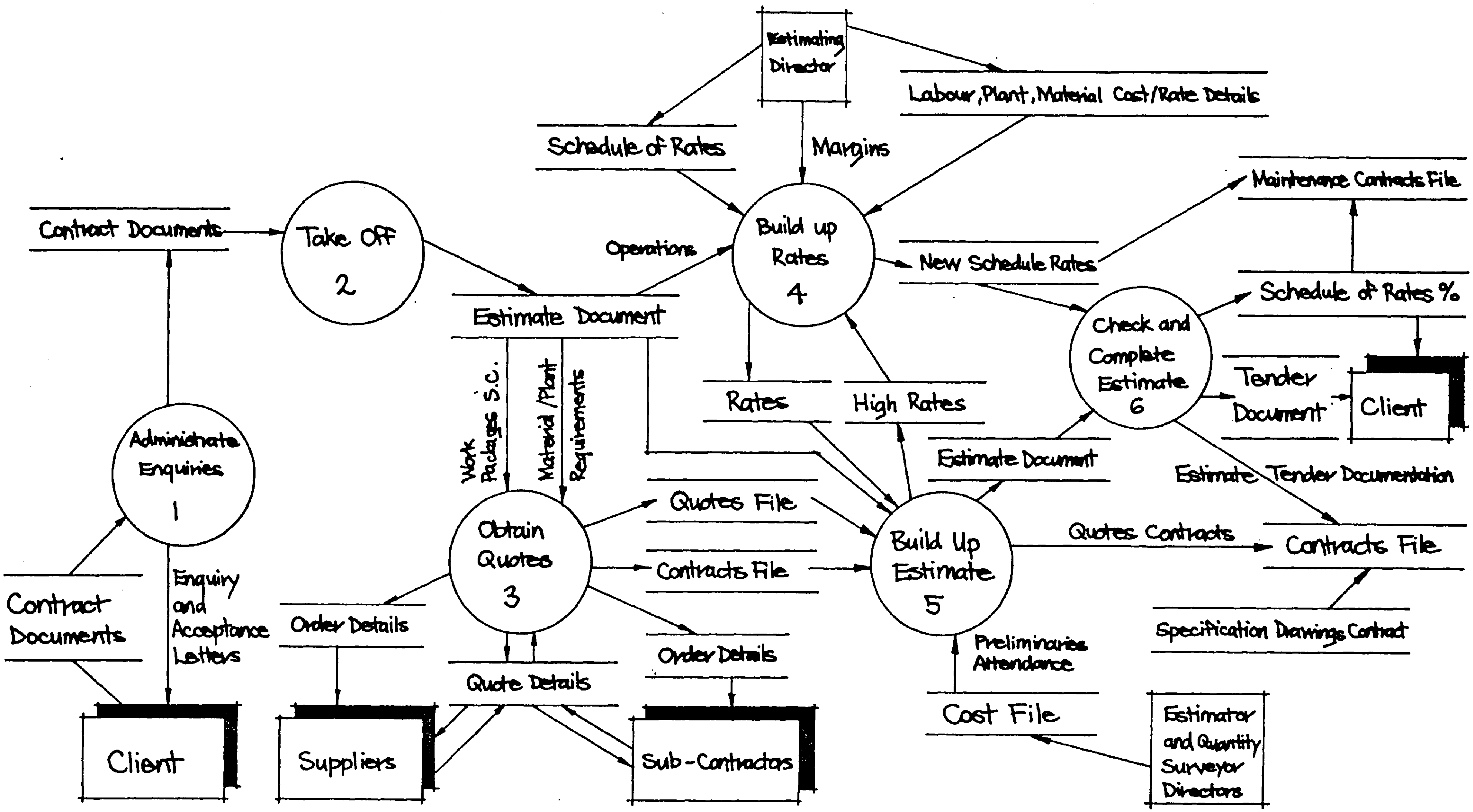


Figure A1.16.0. CONTEXT DIAGRAM FOR 'B'.


Estimating Director
Labour, Plant, Material Cost/Rate Details
Schedule of Rates
Margins
Maintenance Contracts File
Contract Documents
Take Off
2
Operations
Build up Rates
4
New Schedule Rates
Schedule of Rates %
Estimate Document
Check and Complete Estimate
6
Work Packages S.C.
Material /Plant Requirements
Rates
High Rates
Tender Document
Client
Administrate Enquiries
1
Estimate Document
Estimate Tender Documentation
Quotes File
Obtain Quotes
3
Contracts File
Build Up Estimate
5
Quotes Contracts
Contracts File
Contract Documents
Enquiry and Acceptance Letters
Order Details
Order Details
Preliminaries Attendance
Specification Drawings Contract
Quote Details
Cost File
Estimator and Quantity Surveyor Directors
Client
Suppliers
Sub-Contractors

Fi ure A1.1-

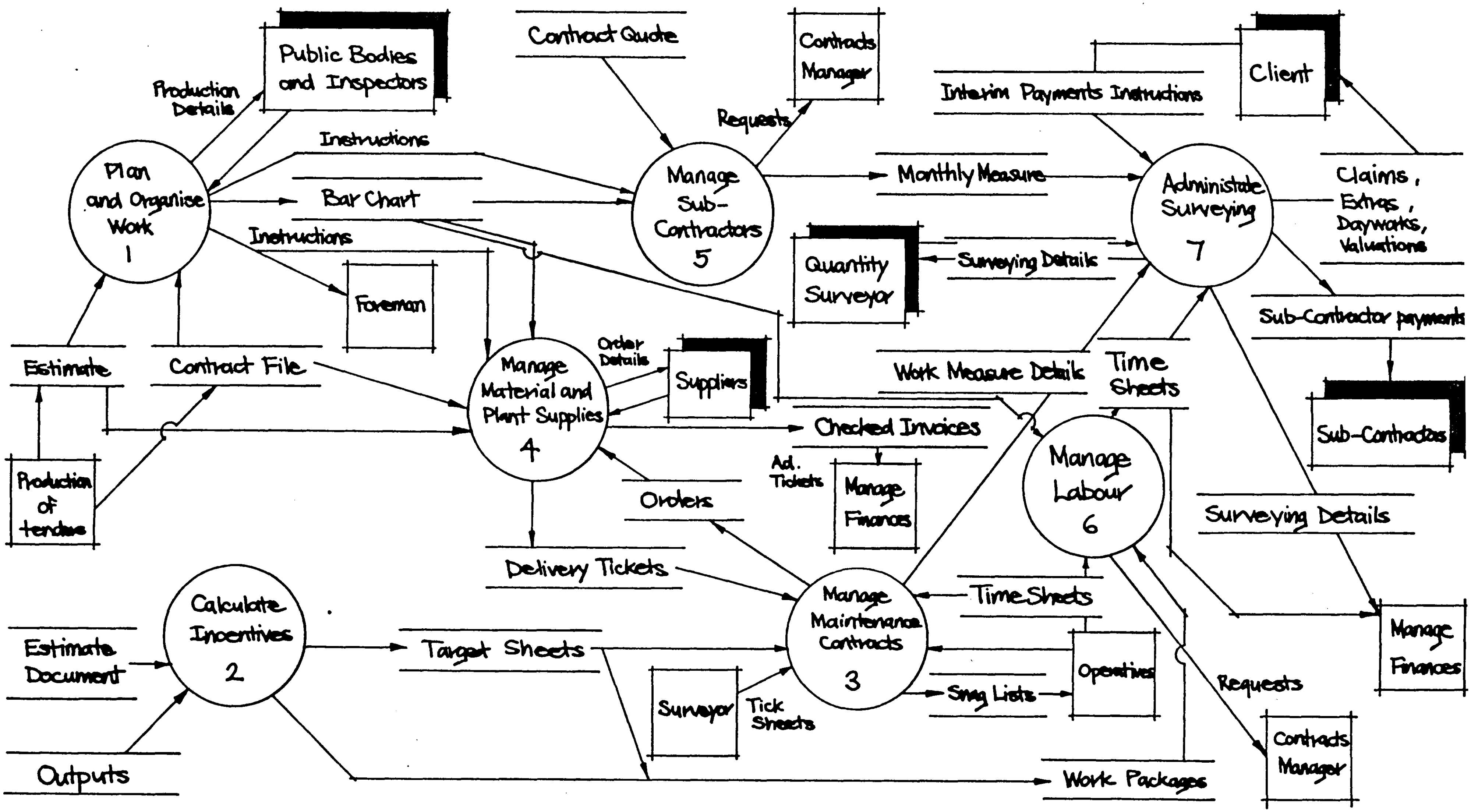


Figure A1.16.2. MANAGE PRODUCTION FUNCTION.

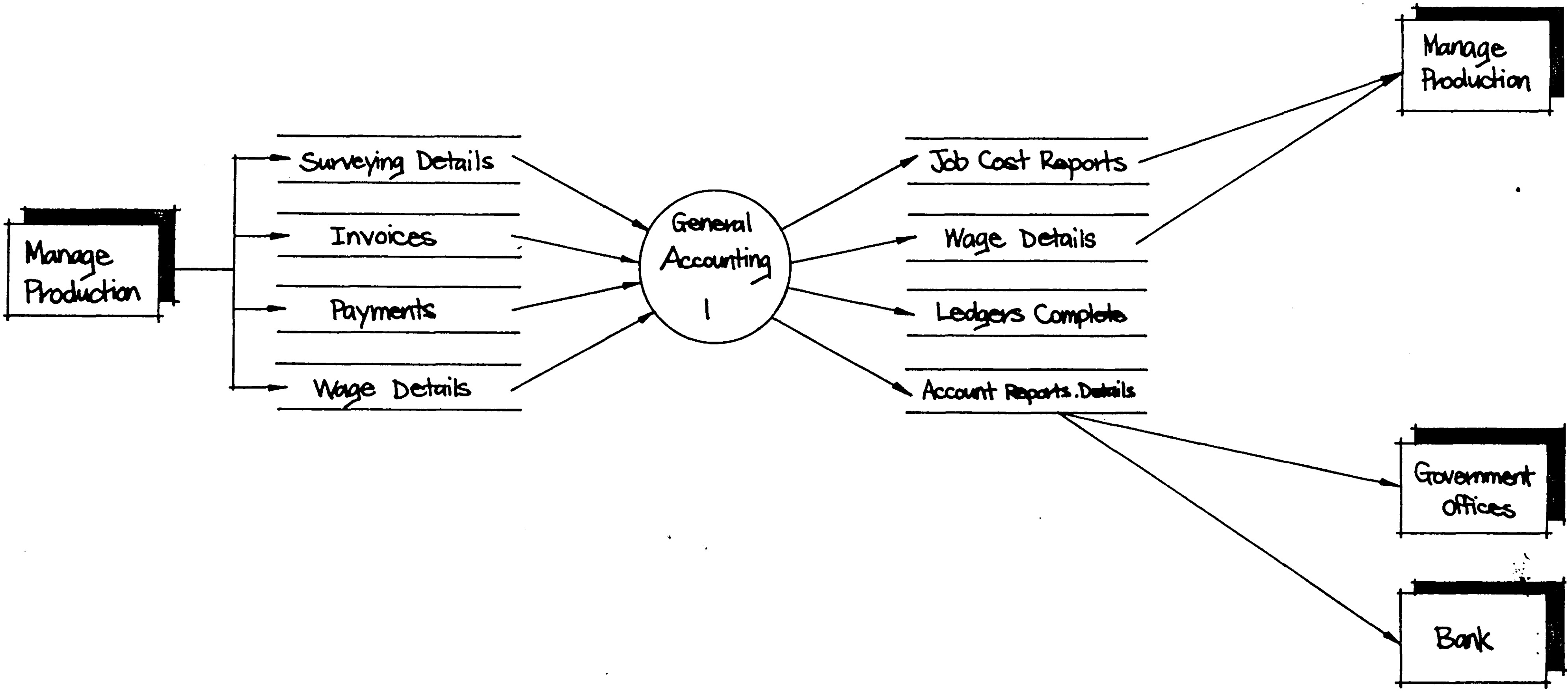


Figure A1.16.3. MANAGE FINANCES FUNCTION.

PRODUCE TENDERS.

1. Administrate Enquiries.

The two directors of the firm decided which work to tender for and handled all enquiries.

2. Take Off.

The detail of the take-off document and estimating depended on the size and type of job.

For contracts submitted on a drawing with a list of work items, the items were priced as spot items. Take off's in terms of operations, were only produced for contracts with just a specification.

When tendering for maintenance contracts, the firm gave an overall percentage figure against a published set of rates, along with a figure for the amount of work they wanted to carry out in a year.

3. Obtain Quotes.

For all contracts, material and plant items and packages of work were separated from the bill or schedule or take off and sent off to sub-contractors or suppliers for quotes. When the quotes were recieved, the most competitive one that met the conditions of the contract was selected and an order placed.

Domestic sub-contractors were usually asked to visit the office to discuss the job and look at the drawings. This saved the cost of copying drawings and ensured good control from the start, as future problems were discussed and solved before work started.

1. Build Up Rates

For each item in every job, unit rates were built up from all in labour, plant and material rates and a margin for overheads and profit. Labour outputs for operations were based on experience and if necessary work study data was used to build up an accurate all in labour rate. The work study information was built up by a large national contractor and was not generally available.

For smaller contracts, unit rates were applied to items and operations as it was not worth the estimator's effort to calculate an elemental breakdown of all in rates for each item.

On maintenance contracts, unit rates were built up from an analysis of work study data and the firms experience gained in carrying out the work over the last few years. Once the unit rates had been calculated, and compared with the schedule, an average figure was worked out which told the client the overall percentage difference, + or -, between the firms tender rates and their own.

5. Build Up Estimate.

Once the unit rates had been calculated, the estimate was built up including quotes from sub-contractors and suppliers and any provisional or prime cost sums. An allowance was added to the sub-contractors quote for attendance if needed. Preliminaries were then added to the estimate.

6.Check And Complete Estimate.

A rough complete copy was prepared by the director, and a fair copy prepared by a clerk. This allowed the director to check the estimate and the clerk to check the calculations. A tender offer was then sent off to the client.

MANAGE PRODUCTION.

1. Plan And Organise Work.

General organisation of the work was done by the directors. As a job started up, it was given a job number and files were opened.

Formal planning of jobs was done if the client requested it, or if the contract value was over £50,000. Durations for operations were worked out from experience and not the estimated labour contents. Durations for sub-contractors were worked out with them, during discussions.

2. Calculate Incentives.

The detail and accuracy of incentives was based on the type of work. For contracts where the operations were estimated in terms of unit rates for labour, plant and material, targets were built up into work packages for the major trades. The work packages were sections of trades that were easily controlled and remeasured on site, eg. carpentry-first fix.

For smaller jobs of around approximately £10,000, targets given were usually for whole trades, for example carpentry, both first and second fix as the same operative would do all one trade.

For contracts where the estimate was priced with all in rates or spot items, no accurate analysis of the labour content could be made. The contract manager gave the operative a target worked out mentally from the operation or item rate, making an allowance for the material and overhead costs. The targets were given to the operatives as a piece rate for completing an operation. This meant targets were in terms of a cash sum for completing work rather than hours for doing the job. As there was no remeasurement of the work, this reduced the cost of calculating the hours saved if the targets had been given in terms of hours. Targets were noted down by the contracts management and the operatives told verbally.

Control of the targets was through information given on the time sheets and site visits. If the work was not good enough, the operative had to go back and complete it to get paid any bonus due.

3. Manage Maintenance Contracts.

Maintenance contracts were carefully controlled. Schedule of rates for the work were used to set the targets. An all in incentive target was given to the operatives to complete a whole operation, including collecting materials, and clearing up.

The operatives were given an address sheet weekly, which told them where the work was. The work completed was checked and measured weekly by the surveyor. To help him do this, tick sheets were used for the various contracts and snagging lists made up of defective work. A crude check was made between the estimate and bonus payments to make sure that the operatives did not claim for more work than was in the estimate.

1. Manage Material And Plant Supplies.

For large jobs, materials required were taken off the drawings and a delivery date worked out from the bar chart. The material was called off from the supplier.

For small jobs, materials were taken from the stores.

When delivery tickets were received for materials, they were given a job number and then checked against the original order and the invoice received, by a clerk. Large invoices, usually from plant suppliers or sub-contractors were checked by one director.

The same ordering procedure was used for plant items. Materials were usually delivered to sites using the firm's own transport with the driver recording the details. This provided a check on the flow of materials and transport costs could be allocated to specific jobs.

5. Manage Sub-Contractors.

Coordination and control of the work and sub-contractors was done by the directors.

6. Manage Labour.

To control the work on site, frequent visits were made to the sites to supervise the operatives and foremen. Time sheets were checked and any problems with targets or wages paid would be sorted out.

7. Administrate Surveying.

Measurement of work on site and the surveying work for the contracts was done by the quantity surveyor. Claims for extras against the contract and daywork were identified by the directors and surveyor. All remeasurement of the work and administration of payments to sub-contractors and claims for payment from the client were worked out by the surveyor.

MANAGE FINANCES.

1. General Accounting.

All the accounts were performed on a integrated computer package. The package automatically updated all the files when one entry was made.

Each job was allocated a job number. All invoices were allocated to a contract and to one of 100 cost categories set up by the firm. Overhead costs such as staff costs, transport were allocated to contracts.

Details of operatives time sheets were inputted to the computer and the wage details calculated automatically. Labour costs were allocated to contracts by allocating percentages of an operatives time to the respective job. Control of costs on contracts was attempted monthly. A job ledger summary report could be printed which outlined client's valuations to costs, split up into labour, plant, material, subcontract and overheads. An indication of how the costs were varying from the budget was given. If any job's figures varied too greatly a detailed job summary report could be looked at.

If any cost category seemed high on the summary of job details, they could be checked but this was a laborious procedure as the orders and invoices for the job had to be searched for and checked.

From this job costing information the package performed all the general accounting procedures.

A cash flow forecast for the next three months was produced which was very useful for controlling the firm's overdraft and interest payments to the bank.

1.6. PROBLEMS WITH B's SYSTEMS.

PRODUCE TENDERS.

Estimates for small contracts were based on all in rates for items. They were built up this way because the contracts were small and the estimator did not have the time to estimate them in detail. If estimates were built up elementally, a more detailed estimate could be built up which would allow greater control of costs during construction.

There was no feedback to the estimator about the accuracy of rates or outputs used because of the administrative work involved in sorting out and comparing the job costs to the estimated costs of operations.

MANAGE PRODUCTION.

If elemental type estimates were produced, the setting of targets could become more accurate for smaller contracts. Operation labour costs could be identified and used as a basis for targets, as being done at the moment on larger contracts. Rather than making a mental calculation of the labour content from an all in rate, the targets would be based on calculated labour costs.

Targets set for maintenance contracts were directly related to the estimated rates which enabled feedback on the accuracy of the estimators rates. If initial targets were based on work study then the efficiency of the scheme should increase. Bonus payments were directly related to the amount of checked and satisfactory work completed.

No material and plant return sheets from sites were used. Amounts were checked through the invoices, delivery tickets, orders and the firm's driver's returns.

MANAGE FINANCES.

The system provided the information required at the right time. Cost control was limited by the problem of the late arrival of invoices making any cost control out of date and its use limited. In the opinion of the director, it would not be worth while to progressively monitor material or plant costs as their supply of them should automatically control their use.

1.7. INITIAL STUDY OF C.

1.7.1. HISTORY OF C.

C started as small private builders in 1857 as property repairers and as suppliers of labour to local works. The firm steadily grew and started to take on general building and civil engineering contracts. Around the late 1960's the firm supplied a lot of contract labour to the steel industry. The firm then decided to concentrate on civil engineering work and around 1971 no private contract work was taken on.

In 1978 the firm was taken over by its present managing director, and formed into a limited company. As the workload started to decrease the firm reverted to general building. Their turnover was approximately £600,000 with over 80% of this coming from specification and drawing type contracts.

1.7.2. ORGANISATION AND MANAGE STRUCTURE OF C.

The firm was controlled by a managing director, who took all the strategic decisions of what work to tender for, the competitiveness of tenders and overall control of the firm. He was helped by a surveyor who was responsible for the surveying and financial control of jobs as well as all the taking off. The management and control of production on site was the responsibility of a contracts manager. Between them, they controlled and co-ordinated all the work involved in fulfilling contracts. See Figure A1.18.

The administrative tasks were carried out by three clerks who did the invoicing, accounts, wages, filing, estimate calculations and typing between them.

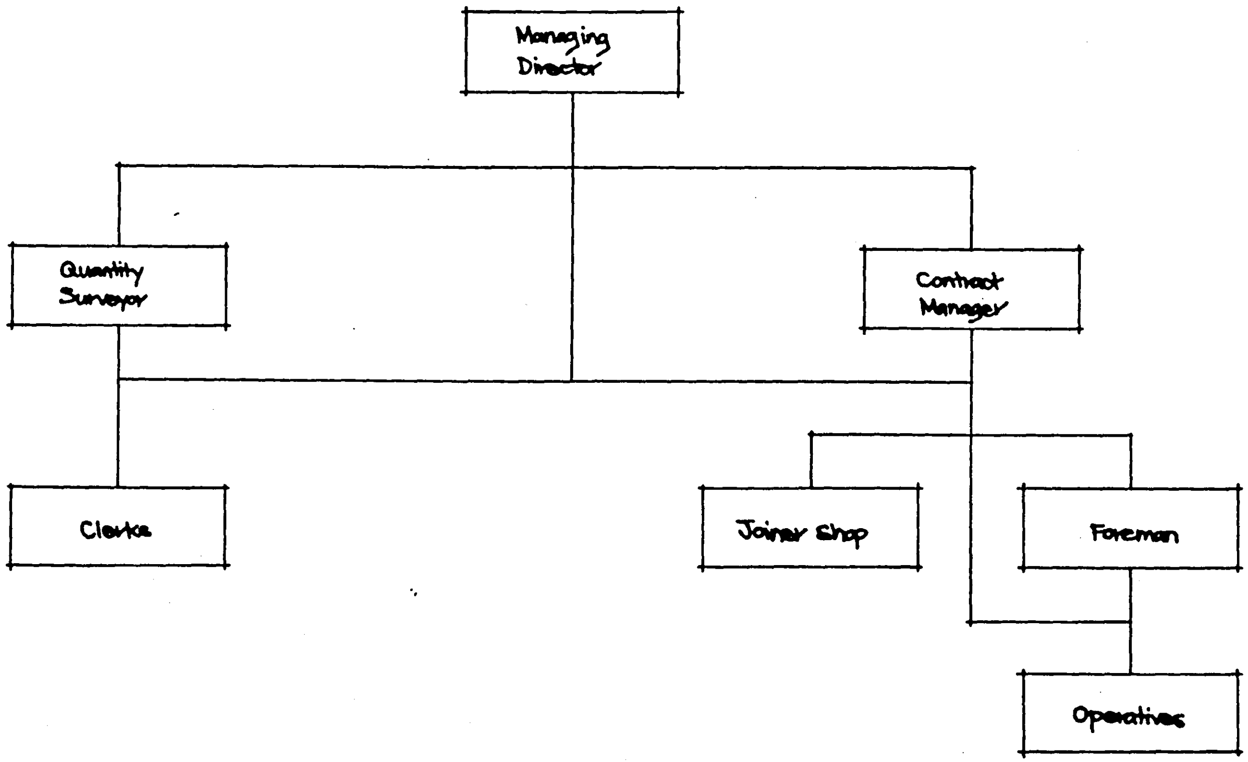


Figure A1.18. ORGANISATION STRUCTURE FOR 'C'.

1.8. STRUCTURED ANALYSIS OF C's MAJOR FUNCTIONS.

See Figure A1.19. Function Matrix Diagram and Figure A1.20. Information Flow Diagrams.

Figure A1.19. Function Matrix Diagram For C.

RESPONSIBILITY / FUNCTION	MD	QS	CON MAN	FOR MAN	CLERK
BUILDING.	X				
ADMINISTRATE ACCOUNTS	X	X			
Forecast Finances	x	X			
Calculate wages.		x	x		X
General accounts.		x	x		X
Control costs		X			
PRODUCE TENDERS.	X	X			
Administrate enquiries.	X				
Take-off		X			
Obtain quotes.		X			
Build up rates.	X				
Build up estimate.	X				x
MANAGE CONTRACTS			X		
Plan and organise work.	x	x	X	x	
Calculate incentives		X			
Manage labour.	x	x	X	x	
Manage sub-contractors.	x	x	X		
Administrate material and plant.	x	x	X		x
Administrate surveying.		X	x		

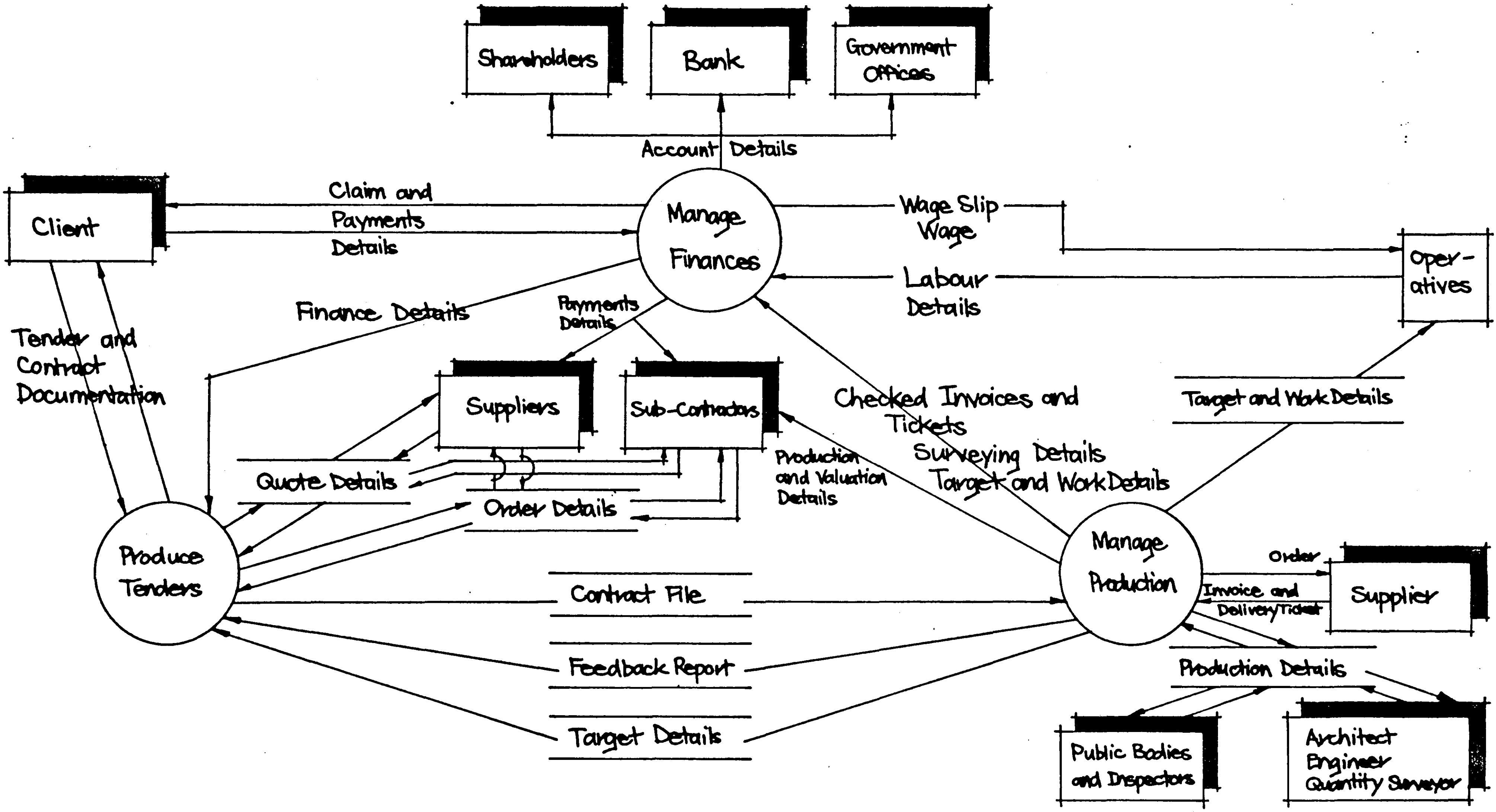


Figure A1.19.0. CONTEXT DIAGRAM FOR 'C'.

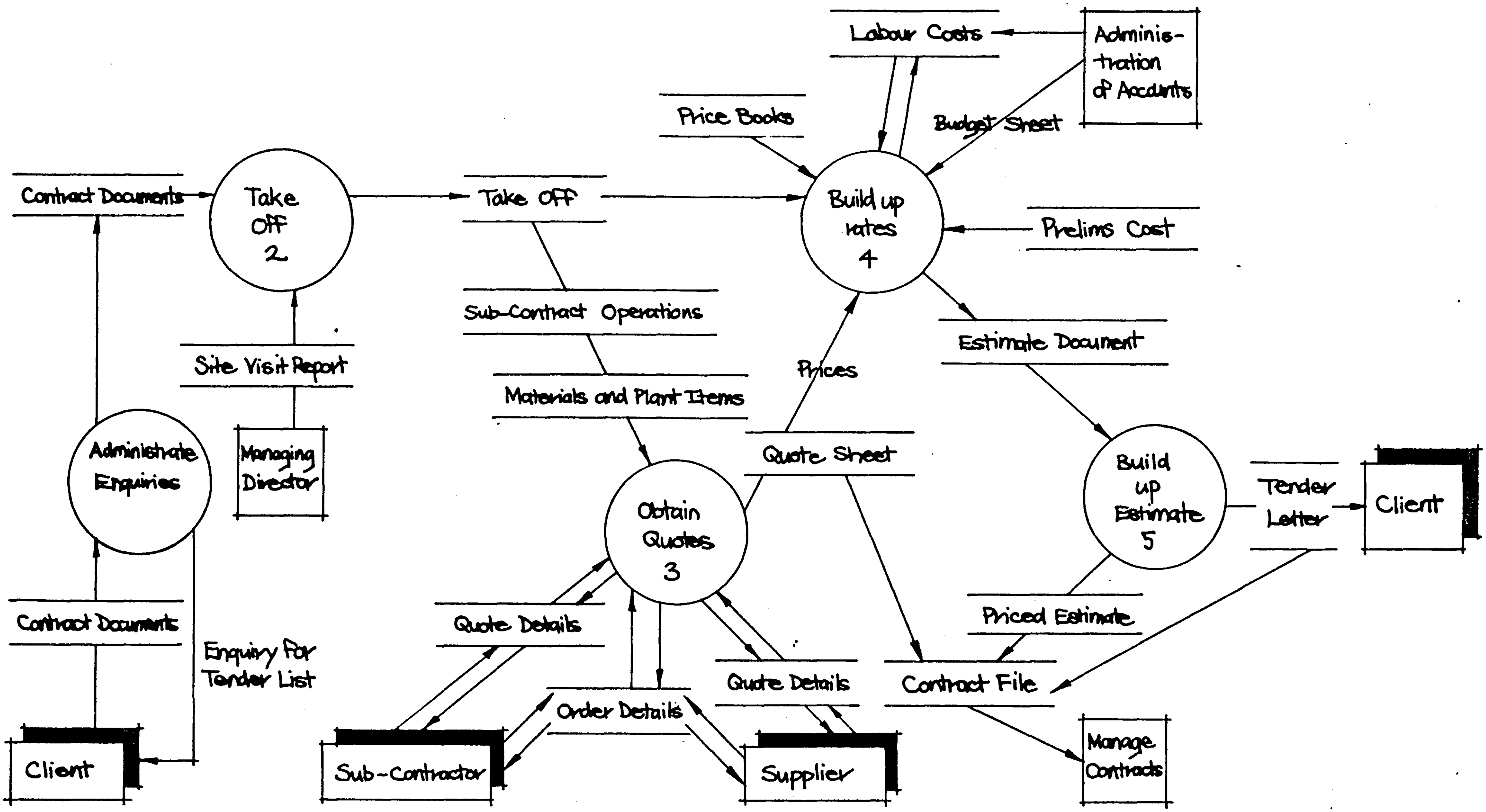


Figure A1.19.1. PRODUCE TENDERS FUNCTION.

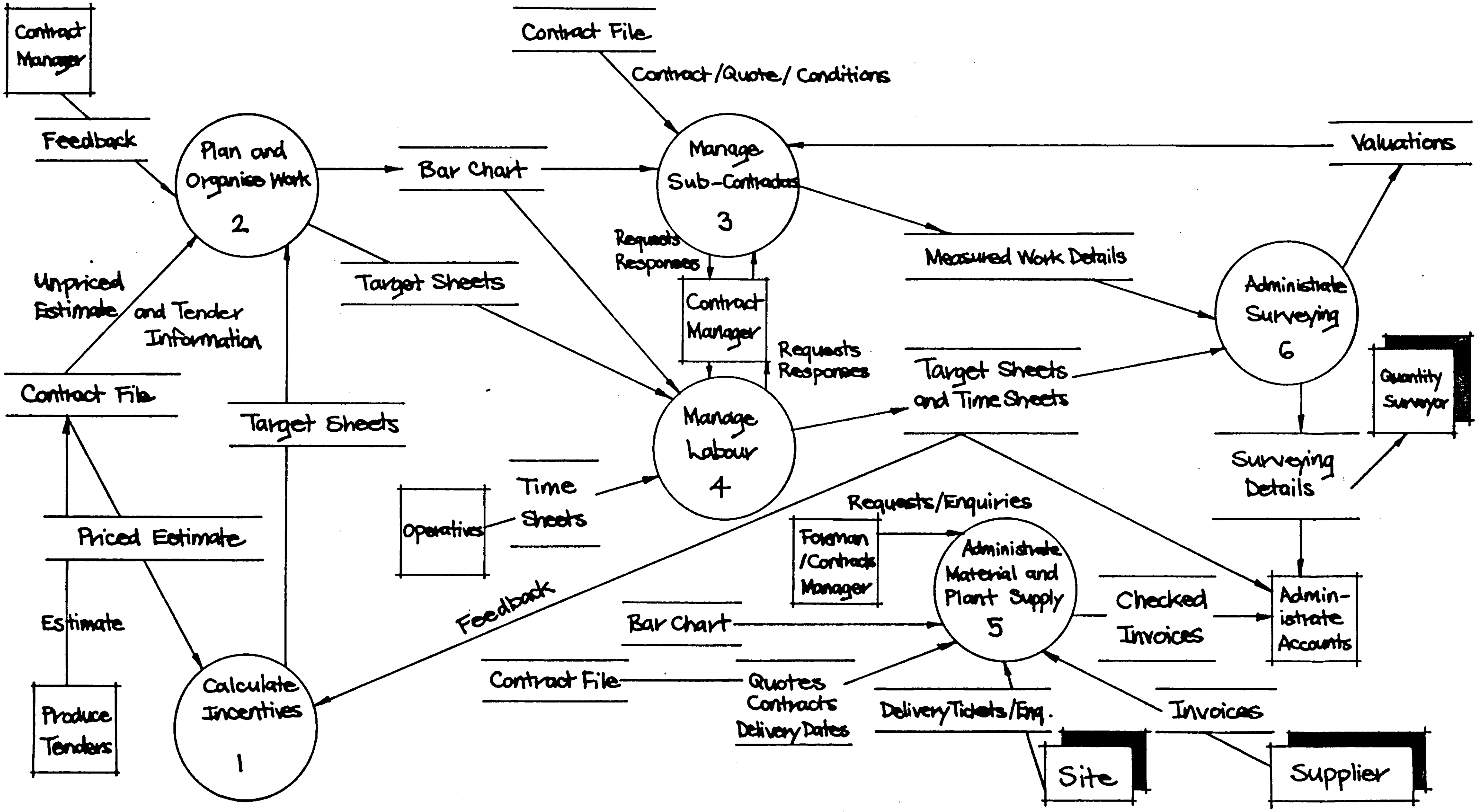


Figure A1.19.2. MANAGE PRODUCTION FUNCTION.

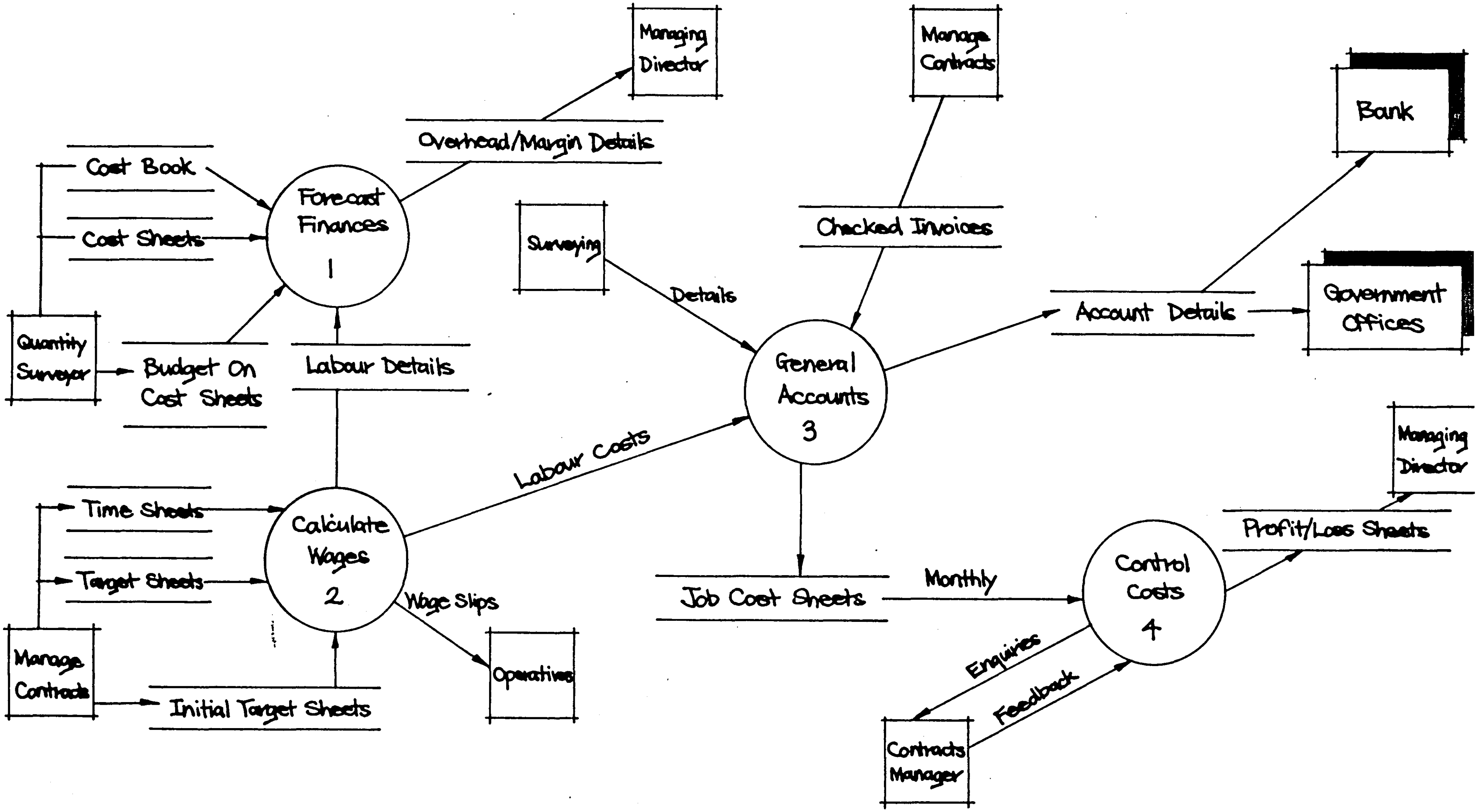


Figure A1.19.3. ADMINISTRATE ACCOUNTS FUNCTION.

PRODUCE TENDERS.

1. Administrate Enquiries.

The managing director applied for the firm to be put on tender lists and handled all enquiries for work.

2. Take-Off.

Once a tender offer had been accepted, the surveyor took off all the work in detail, using the standard method of measurement-SMM6. C had the policy of producing all estimates and tenders to the same level of accurate detail, for all types and sizes of job.

3. Obtain Quotes.

As take-offs were built up, work packages were assembled for sub-contractors to price. The keenest quotes were accepted and noted down on a quotes sheet and kept with the take-off document.

Quotes for material and plant items were requested from suppliers and hirers. The lowest quote which gave the necessary requirements was accepted and an order placed.

1. Build Up Rates.

Once the take-off had been completed it was handed to the managing director who built up rates for each item.

The unit rates were built up from labour, plant and material rates and subcontract quotes. The labour rate was made up of the basic labour cost and an extra amount which covered overheads and a margin. This was worked out from the total cost of overheads for a year, divided into the total number of hours worked by all operatives in the year to give an extra hourly rate. This was added to the labour rate.

Outputs for labour were worked out from experience and memory. If a work item's labour output was unknown, a number of price books were referred to, and an estimate made of the likely output.

There was a certain amount of feedback on the accuracy of the outputs from the incentive scheme which was used on all jobs.

Plant rates were worked out from experience and records of actual costs of hire or use.

Material rates were built up from costs kept in a materials cost file. Upto date quotes for material costs were asked for from suppliers to make sure that rates are correct.

Subcontract costs are taken from the quotes sheet written out by the surveyor and applied to the estimate by the director.

5. Build Up Estimate.

Separate rates were summated into all in rates for each item. Once all the items had been priced and the estimate built up, the director quickly checked through the estimate making sure that everything had been priced. The director then checked the expected rate of return and margin. By setting margins for each item and maybe a lump sum as well, the director made the final tender price as competitive as he felt necessary.

A clerk performed the calculations to finish the estimate.

The final estimate was checked to see that every item had been built up and priced correctly, by the director and surveyor.

The director then wrote a tender letter to send to the client with a tender price and a breakdown of the work priced. It was felt that by giving the client a detailed analysis of the work and its costs, the client would be more likely to give them work in the future.

All the information used in building the tender was then placed in a separate numbered contract file.

MANAGE PRODUCTION.

1. Calculate Incentives.

For accepted tenders, the surveyor calculated targets from the estimate document. For each item, the total monetary labour content was extracted and converted into hours. From these item targets, target sheets were written out for the contracts manager. The overall size of the target sheet depended on the size of the job and the labour which was planned to be used. For small contracts where only one trade was involved, a lump sum target was broken down into items for the whole job. For larger contracts the target sheets were broken down into separate trades.

The sheets were given to the contracts' manager who gave them to the operatives.

2. Plan And Organise Work.

Bar charts were drawn up by the director to control production for contract values over £20,000 or if the client requested one. The bar chart was drawn up using the labour targets worked out for the target sheets by the surveyor.

For short term planning, straight line bar charts were drawn up based on experience.

The contract manager was given a contract file with all the information used for estimating, but the estimate document was unpriced.

The contract manager was responsible for the day to day planning and organisation of work on sites once they started up. Start up of sites and all the necessary contacts with professional bodies and people was by the director and surveyor. They also organised the overall co-ordination of contracts. The contract manager was responsible for getting the work completed on time, budget and acceptable quality.

Each week the three managers held a meeting to plan the work ahead. Priorities and problems were sorted out and the work in progress co-ordinated. As all the managers work in the same office there were frequent opportunities to discuss and solve problems.

3. Manage Sub-Contractors.

The management and control of all sub-contractors on site was carried out by the contracts manager.

1. Manage Labour.

Labour was controlled by the contract manager. Larger sites were run by general foremen, joinery foremen and chargehands to help the contracts manager run the job.

Organisation of the incentive scheme after the targets had been worked out was the responsibility of the contracts manager. When he received the sheets he checked the targets and allocated the work to operatives. Control of the work was achieved by the manager visiting the sites to supervise and control the work carried out.

Each operative gave in a time sheet, weekly, detailing the contract, work done and any daywork or extras which were carried out. Details were checked by the contracts' manager then given to the surveyor for building up and verifying claims and extras.

The majority of disputes with operatives were sorted out by the contracts manager and managing director with the operatives themselves.

Time sheets were used by clerks to calculate the wages and bonuses for the operatives. The bonus paid was equal to the time saved by the operative in carrying out an operation. The operative received all the time saved as a bonus paid back at the basic rate.

The director who built up the rates was able to get some feedback on the accuracy of the outputs he used for estimating from details of the bonuses paid.

5. Administrate Material And Plant Supply.

The contract manager controlled the supply of all materials and plant. Materials required were taken off, and the date required calculated by the contracts manager who instructed the director or surveyor who sent the orders to suppliers. Each contract had a separate file for the buying of materials. When invoices were received for goods, they were first checked by the director for the price. A clerk then checked them against the delivery note received and signed on site and allocated the invoice to the relevant job.

Authorisation to pay the invoice was given by the surveyor for sub contract payments and the director for material payments.

The supply, administration and checking of invoices for plant was done by the contract manager.

Surveying.

The surveyor was responsible for the measurement of all the work on site and administration of all payments and claims to and from sub-contractors and the client.

ADMINISTRATE ACCOUNTS.

1. Forecast Finances.

The amount of work required to cover overheads and costs was calculated from the monthly profit and loss sheets for contracts and details of the firms overheads.

Over a period of time, figures were compared and analysed to see how profitable the firm was in its different markets.

Calculate Wages.

Wage details were calculated by clerks from time sheets which had been checked by the contracts manager.

Manage Accounts.

C used a self designed accounts system; similar to the Kalamazoo system; administered manually by three clerks and the surveyor.

Contract accounts were drawn up by the clerks and surveyor.

Once invoices had been authorised for payment, a clerk entered the details into the accounts.

The cost of all plant, material, labour, sub-contractors and extras were charged to their respective contracts weekly, by a clerk, onto job cost sheets. Each different type of job had a separate file for its cost sheets. If a lot of work was done for a client, the cost sheets were kept separate. Small jobs were all grouped together in one file.

Control Costs.

The surveyor used the cost sheets to draw up monthly profit and loss sheets which for each job showed, costs and paid valuations, which gave an indication of its profitability.

Once the final account was settled, an allowance for the cost of staff overheads before the final margin was calculated.

For jobs which were still running, the figure was only approximate and of limited use as invoices and payments were at least a month behind work on site.

1.9. PROBLEMS WITH C's SYSTEMS.

PRODUCTION OF TENDERS.

The major problem in producing tenders was the workload involved for the surveyor and director in taking-off the work and pricing it. This was because all take-off's and build up's were done in great detail to enable close control of jobs during construction.

The problem was acute with specification and drawing contracts, as detailed take-offs had to be prepared along with the build up of an estimate. The problem was not so serious for bill of quantity type contracts as not as much work was involved. As well this the firm found the calculation of upto date material prices hard work.

Output rates were built up from experience, memory, reference to price books and a certain amount of feedback from the incentive scheme. As the operatives got paid all the hours saved in their bonus, the scheme needed accurate targets otherwise it would be unprofitable.

Overall the targets were reasonably accurate as the operatives accepted them and the firm was making profits. It was felt by the director that if more accurate outputs could be ascertained the bonus scheme would become more effective as productivity rose and costs decreased.

MANAGE PRODUCTION.

Problems arose with the running of the incentive scheme. The administrative work calculating the targets from the estimate took a lot of effort. The information used to calculate the targets had already been sorted once to build the estimate prices and it was then re-sorted to calculate targets. Once calculated they were written out onto target sheets, in a format which the contract manager could give to the operatives, after checking them.

Misunderstandings occurred between the operatives and management about what had been allowed for in the targets and also the settlement of extras and dayworks.

The operatives received all the hours saved as a bonus. The firm did not take anything out for the administrative costs of running the scheme. This meant that the firm had nothing to fall back on if the rates were incorrect. The rates were built up from experience and the firm took the attitude that if the rate was used in the estimate then they could not lose on the bonus payments.

MANAGE FINANCES.

C administrative accounts were based around a self designed system using a number of standard forms which were filled in by the clerks and the surveyor. The surveyor knew how each contracts costs were running at monthly intervals, except for invoices and payments that had not been cleared through the system due to being a few weeks behind. When the final accounts were complete the profitability of each contract was known and was compared with similar ones to assess the performance.

1.10. INITIAL STUDY OF D.

1.10.1. HISTORY.

D was formed by its present proprietor in 1953, carrying out building repair work and subcontract work around Derbyshire. In the 1960's the company started to expand into general building contracting, particularly housing work. Since then, the company has steadily grown, taking on bigger and more complex jobs up until the late 1970's. During this period the majority of the work was "one off" quality work. The company employs approximately forty operatives and five management staff. Contract values vary from a few pounds to approximately £200,000 with a yearly turnover of £750,000. Now, the majority of the workload comes from government funded bodies and "one off" quality work based on specification and drawings.

1.10.2. ORGANISATION AND MANAGEMENT STRUCTURE.

D's organisation was a two tiered structure. See Figure A1.21.

The proprietor controlled the overall running of the firm and took the strategic decisions.

The management of individual contracts was the responsibility of four contract managers. One controlled all the small jobbing works and the company safety policy while the other three took on separate projects, undertaking all the functions from estimating right through to the final accounts stage.

The day to day management of the firm's labour was carried out by the proprietor. The proprietor tended to take a paternalistic management attitude towards the operatives and their problems. He kept close control over all the directly employed operatives by personally allocating them to contracts on a daily basis, taking advice from the contract managers.

There were three office staff who handled the general office administration and accounts which allowed the contract managers to concentrate on managing the jobs.

On sites where there was continuity of work for a number of gangs, the labour was supervised by a general foreman or senior tradesman. Gangs of labourers and scaffolders were organised by gangers.

The firm had a joiners shop from which all the firms joinery requirements were met. It was managed by the joinery shop foremen and the contract managers.

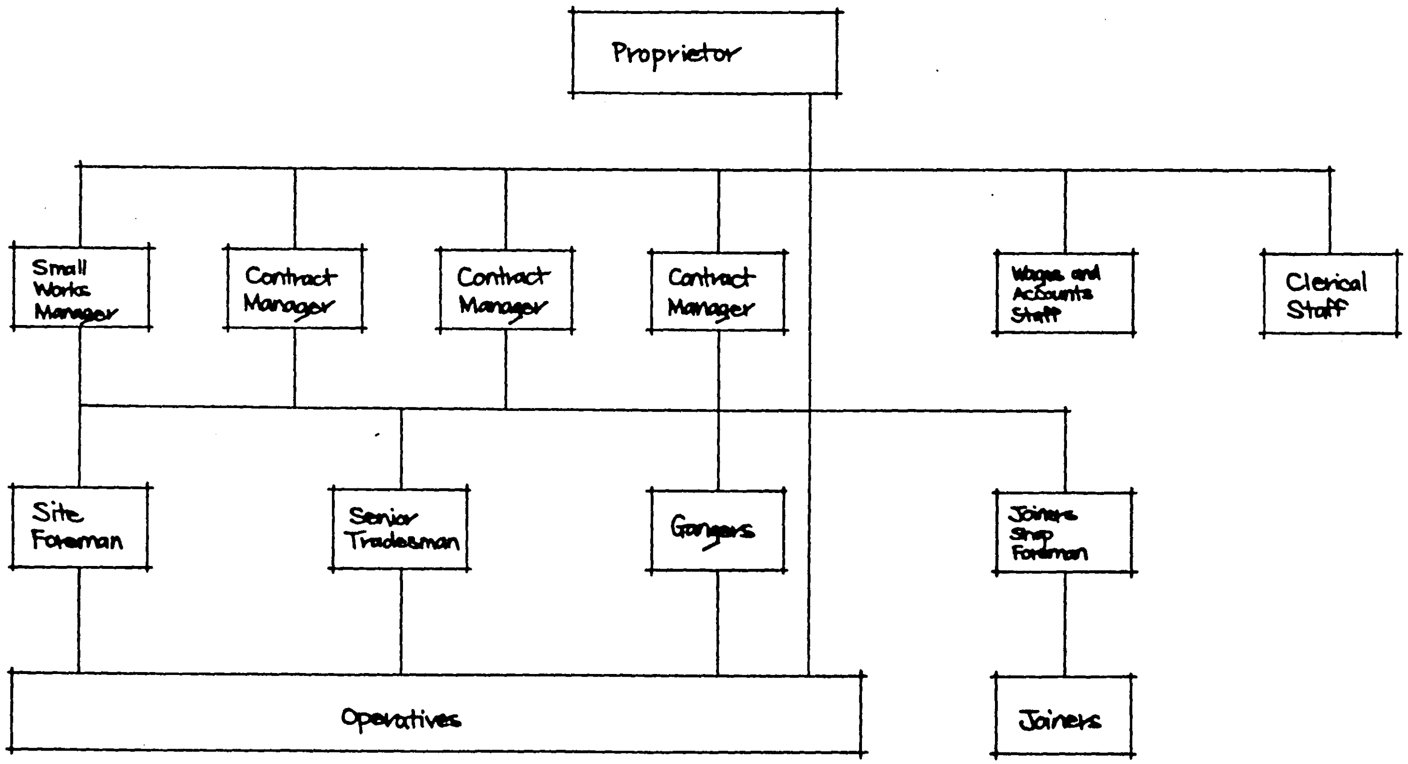


Figure A1.21. ORGANISATION STRUCTURE FOR 'D'.

1.11. STRUCTURED ANALYSIS OF D's MAJOR FUNCTIONS.

See Figure A1.22. Function Matrix Diagram and Figure A1.23. Information Flow Diagrams.

Figure A1.22. Function Matrix Diagram For D.

RESPONSIBILITY / FUNCTION	PRP	CON MAN	SMLL WKS MAN	FOR MAN	CLERK
BUILDING.	X				
FINANCIAL ACCOUNTING	X	X			
Calculate Wages.					X
General accounts.					X
Job Costing		X			X
Contract accounts.		X			X
CONTRACTS MANAGEMENT	X	X	X		
Administrate enquiries.	X	x			
Take-off and estimate		X	X		
Obtain quotes.		X	x		x
Planning	x	X	X		
Manage daily running of jobs	x	X	X	x	
Surveying		X			x

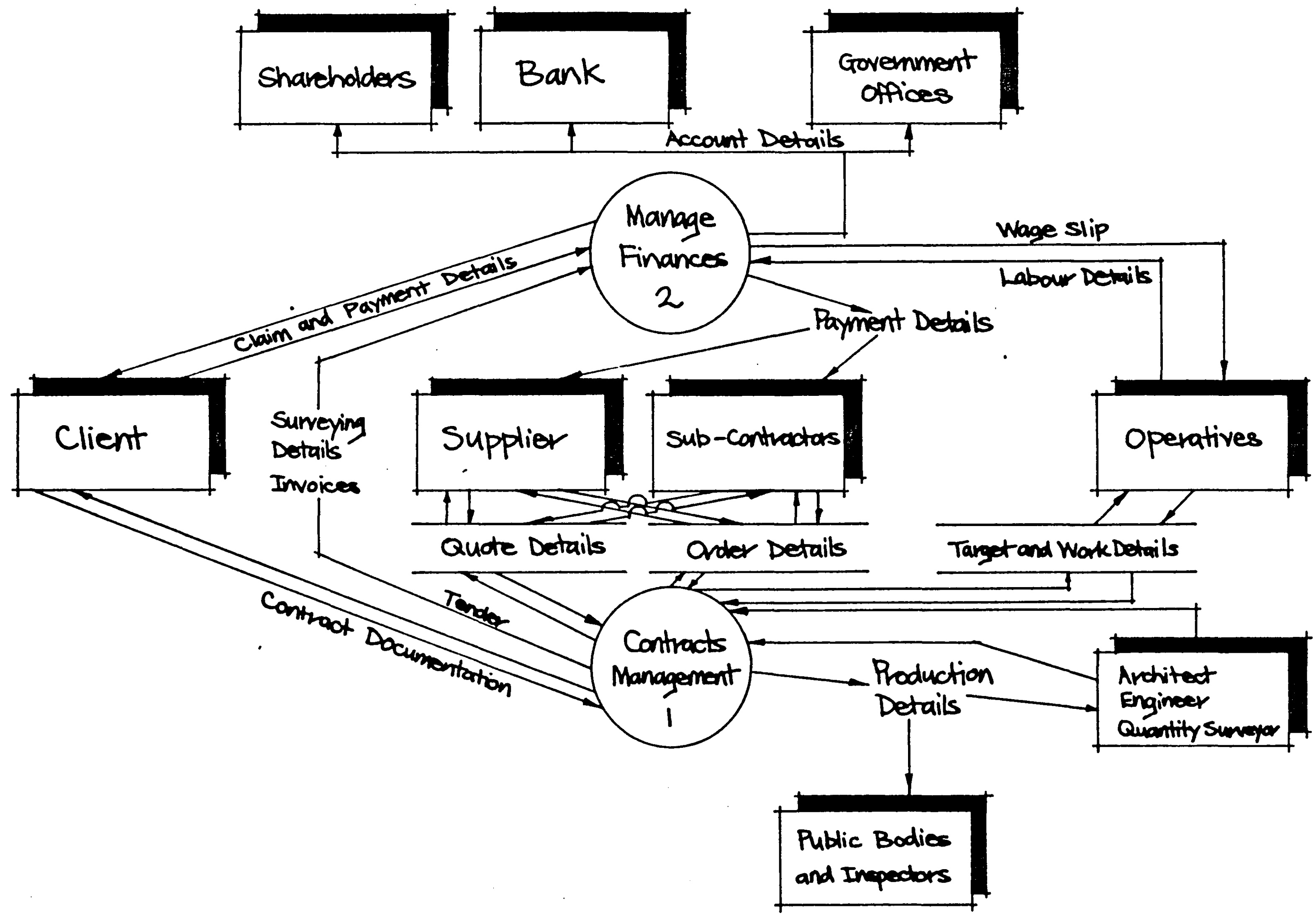


Figure A1.22.0 CONTEXT DIAGRAM FOR 'D'.

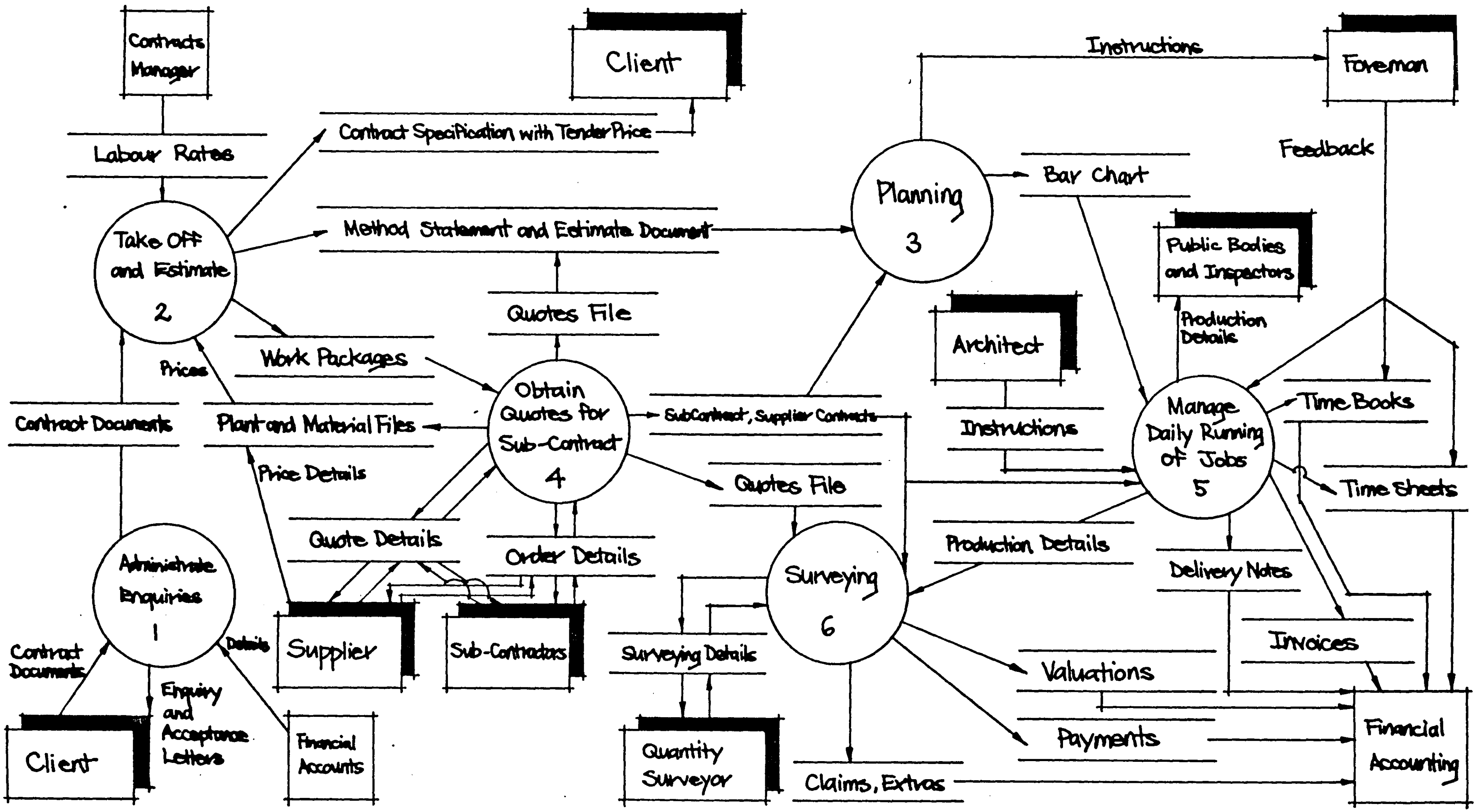


Figure A1.22.1. CONTRACTS MANAGEMENT FUNCTION.

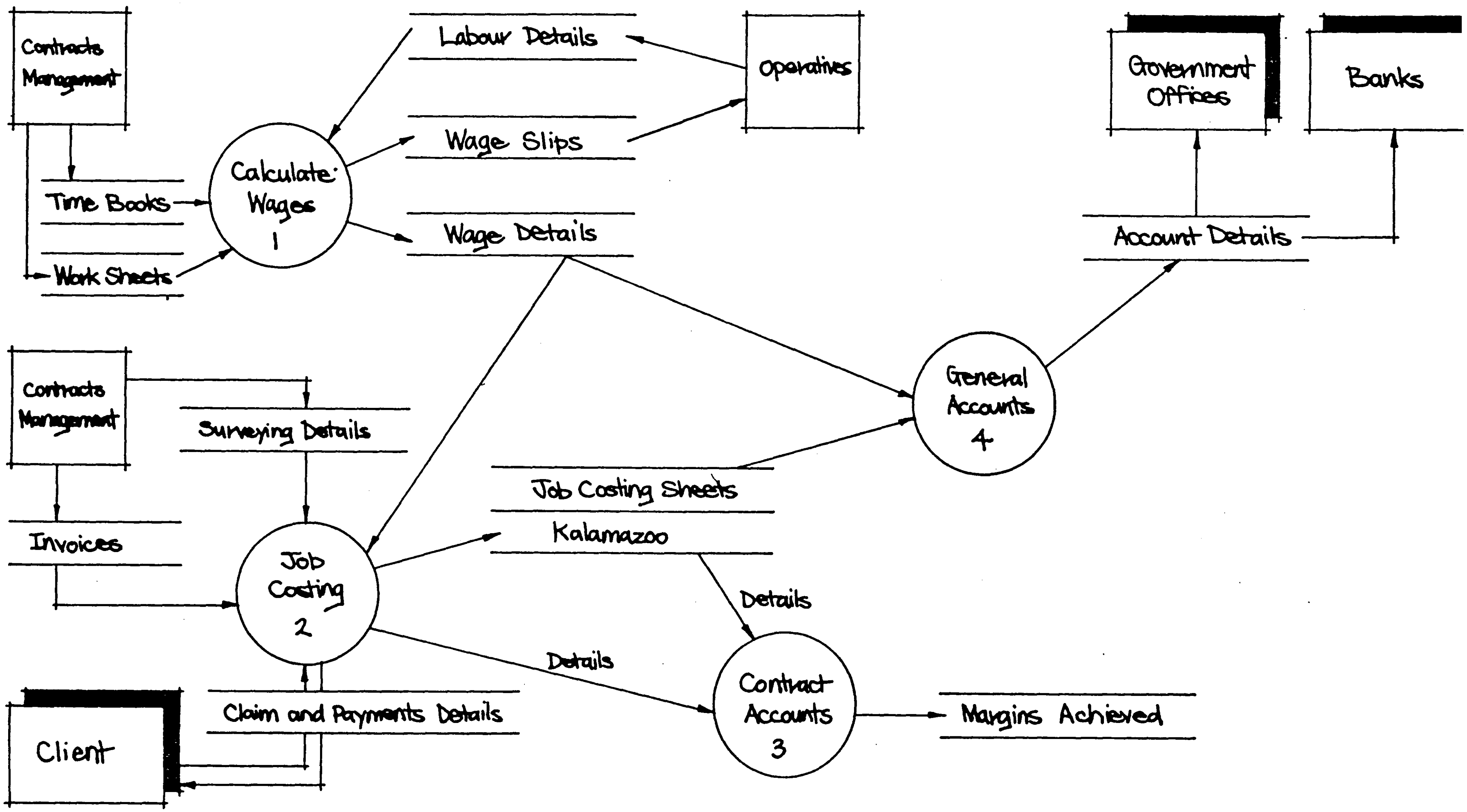


Figure A1.22.2. MANAGE FINANCES FUNCTION.

CONTRACTS MANAGEMENT.

1. Administrate Enquiries.

The proprietor along with the contracts managers handled all the enquiries for tender work. The proprietor sent off requests to be included on tender lists, to clients.

As tender documents came into the office, the proprietor, with advice from the contracts manager, decided whether or not to accept the invitation to tender. This depended on the type and location of the work and the firm's financial situation.

When an invitation to tender was accepted, it was allocated to a contract manager.

2. Take-off And Estimate.

All the contract documentation including the estimate, material schedules, drawing and specification was kept in one addressed envelope for ease of reference later.

Each contract manager, handled all the administration and management for each contract, except for the daily allocation of labour which was done by the proprietor.

The majority of D's work was based on specification and drawing and for these contracts a take-off document was hand written. At the head of the document were all the basic conditions that affected the estimate, ie, labour rates, hours worked per week. The take-off was built up in terms of "operations", which were items of work measured in the way they were carried out on site. Labour, plant and materials were priced as separate spot costs for each operation. No separate amount was included for an overheads and profit margin in the estimate. Margins were added into the overall labour rates for the estimate, which were then applied to all the operations taken-off.

Each contract manager's method of estimating was similar but they each used their own rates for prices and outputs.

Against each operation, the plant, labour and material requirements were noted and the managers used these as schedule of requirements. See Figure A1.24. For plant and labour costs the manager estimated the output in terms of hours, calculated the cost and put these figures into the estimate. For material, the manager worked out the wastage, total requirements, delivery dates, handling requirements, costs and noted these in the estimate. For some operations a simple method statement was written outlining the method of work along with any special restrictions or requirements.

Once the estimate was complete, the contract manager and proprietor looked through it to see that all the work had been priced correctly and a fair rate of return could be expected if the work was carried out. The tender price was then sent off to the client. A brief specification of the work items estimated for was included with the tender price, if no drawing was included with the contract documentation. See Figure A1.25.

1 A Compress up exstg conc. apron to required depth for new fdns. Supply & lay limestone h/c, sand blind, d.p.m. & conc. flr. & thickened out [illegible], lay 1½" sand cement screed

5 x 5.6 = 28 } 30.5 m²
1.3 x 1.3 = 2 }

Conc 30.5 x 250 = 7.6 } 32.4
1.8.5 x 750 x .25 = 3.5 }

2000 g poly 35 m² .00
limestone & sand .00
shuttering .00
reinf 17 m x 600 } .00
labour compress up take out 8 & 1 day .25
lay h/c sand poly. reinf 8 & 1 day .25
erect shutter J & A 7 hrs. .75
conc 2 B 2 & 6 hrs .00
strip shutter & make up 8 3 hrs .75
screed 30.5 m² 5 .50

1009 90. 1009 90

2. A Construct walls from Edham Hall matter facing bricks, 50 mm jablite, 100 thermal blocks incl. bonding to exstg walls

perim 18.5 x 3.305 ht = 61.15 m²
ddt window 2.4 x 1.3 - 4 }
2 drs } 3.15

53 m² 45 45

60 [illegible] £63.
100 thermal 4.0
50 mm jablite 2.5
mtr 2.0
labour B. 13/4 10.95
L 1¼ 6.90

FIGURE A1.24.
TAKE OFF AND ESTIMATE SHEET FOR 'D'.

FIGURE A1.25. TENDER LETTER SENT TO CLIENT WITH OUTLINE SPECIFICATION.

6th February,

__For the attention of Mr.__

Dear Sir,

__Proposed Sales Office and Lobby extension at__

Please find below specification for works to the above, our estimate will be £5986.00.

(Five thousand, nine hundred and eighty six pounds)

__Specification__

1. Compress up existing concrete apron to required depth for new foundations,. Supply and lay limestone h/c, sand blind, dpm, and concrete floor and thickened out to 1½" sand cement screed.

2a. Construct walls from Edham Hall, heather facing bricks, 50mm joblite, 100 thermal blocks including bonding andexisting walls.

b. Supply and install galvanised steel lintels over door and window opening with d.plc. etc.,

c. Supply and fix galvanised metal window in timber subframe with double glazed clear glass and quarry tile cill and timber framing and boarding above.

d. Construct flat roof consisting of 8" x 2" joists at 450cc, visqueen v.p., 50 insulation, 19mm plywood, Celatex and 3 layer felt, special flashing to 2 no. flue pipes.

e. Supply and fix p.v.c. coping to match existing.

f. Form new doorway between existing building and new extension, supply and fix new 50/50 glass ½ hr. firecheck door and frame, self closing action.

g. Supply and fix external ply flush door and frame with small glass panel.

h. Supply and fix internal ply flush door and frame to new office.

i. Construct 3" x 2" timber stud partition to cover up pipes.

j. Supply and fix 4" x 1" s.w. skirtingboard to walls and stud partition.

3. Plastering

a. 2 coat plaster to walls including make good where new doorway knocked through.

b. ½" plasterboard and scim to ceiling and stud partition.

4. Drainage

Remove existing manhole cover and frame, build up to new floor level and supply and fix double seal screw down manhole cover and frame, infill type screeded off level with new floor screed.

5. No allowance has been made for the following trades work which the client is carrying out:

a. electrics
b. plumbing and central heating
c. decoration
d. floor covering.

3. Planning.

The estimate was also used as the major document for controlling the contract. See Figure A1.24.

No formal planning of the jobs was undertaken unless the client requested it, and then a simple bar chart was drawn up which was based on general experience and a 'gut feel' for the job. For the majority of work the planning tended to be intuitive, based on a knowledge of the job gained during estimating and general experience.

1. Obtain Quotes.

When taking off the operations the manager sorted out work packages for sub-contractors from which quotations could be obtained. In order to price material and plant items quickly and accurately, details of the requirements were sent to suppliers by telephone initially for a quote. A letter confirming the quote and order was sent for the most competitive. These prices were then built into the estimate.

5.Manage Daily Running Of Jobs.

The contract manager organised the "setting up" and organisation of the work along with any setting out of the work required.

The contract manager used the estimate document for the day to day running of the contracts, and ascertaining the labour, plant or material requirements. For materials supply, the amounts were taken from the estimate document and the amount checked with the drawings for amendments to the design, if any. He organised the supply and delivery to site of materials and plant whether from suppliers or stock.

When invoices were received, they were checked against the order and delivery tickets, then allocated to the relevant contract by the contract's manager. The tickets and invoices were then passed onto a clerk who handled the contract accounts.

The firm did not run any formal incentive schemes on any jobs. The proprietor gave a bonus to an operative if he felt that he had worked particularly well on a job.

The proprietor and contract managers co-ordinated the labour allocation to jobs a few days in advance. Individual tradesmen took little responsibility for running the contracts and tended to give all their problems to the contracts manager who visited each contract daily, or else to the proprietor who they saw each morning when being allocated jobs.

Co-ordination of all the work on site, including sub-contractors, suppliers and the firm's own operatives was done by the contract manager.

6. Surveying.

The contract manager remeasured all of the work and handled the surveying for the sub-contractors and client, including interim claims, dayworks, valuations and payments.

All communications to the client, architect and external parties was through the contracts' manager

FINANCIAL ACCOUNTING.

1.Wages.

Wage calculations were based on individual operatives time books which gave the total hours worked on operations for individual contracts. Details were sent to the job costing and general account activities.

2.Job Costing.

Rough approximations of the margin being achieved on each job was made irregularly. The final margin achieved was calculated after the final accounts stage, as no accurate reconciliation was attempted while a contract was still running. This was because of the inaccuracies involved due to the late arrival of invoices from material and plant suppliers and sub-contractors. The margins obtained were compared to previous similar jobs and if different were investigated by checking through the contract accounts and invoices.

Labour costs were charged to separate contracts for job costing by allocating operatives time to the contracts noted in their time books.

3. Contract Accounts.

Clerical staff brought together all the costs for a job, along with details of payments from the client for contract accounting. On completion of jobs the final margin obtained was worked out.

1. General Accounts.

Contract accounts and the general accounts activities were integrated with wages through the "Kalamazoo system".

1.12.PROBLEMS WITH D's SYSTEMS.

Contracts Management.

Each contract manager took off and priced tenders individually, therefore final tender prices would vary between managers since they did not use standard operations, labour outputs, prices or rates. A time consuming element of estimating was the calculation of material costs due to the enquiries regarding upto date prices. These variances could result in the firm losing or gaining contracts.

The profit and overhead margin was set into each standard labour rate. If the manager felt that a higher rate of return was required for an operation or trade the labour rate was increased. By including the margin into the rate it was hard to identify the actual profitability of operations and contracts later.

The basic organisation and management structure of D resulted in the contract managers having very good knowledge of each job which could, in turn, result in good co-ordination of those jobs. This imposed a very heavy workload on them which led to problems in other areas, as they did not have the time to complete their work properly i.e. cost control achieved at the final accounts stage of the job.

The operatives on site could have taken more responsibility for the simple problems of material shortages, co-ordination and methods of work. This would have reduced the work load on the managers appreciably. As labour was allocated to jobs daily, it meant that labour allocation was very flexible. It seemed illogical that this was done by the proprietor while the contract managers co-ordinated the rest of the job but did not have direct control over the co-ordination of labour.

A proportion of the work force have worked for the firm since it started. With time there has been no incentive to work hard, and their productivity has been slowly reducing over the years. Also a lot of the younger operatives have left to work at the local mine which operates an incentive scheme allowing them to take home considerably more pay. It was felt by the management that the efficiency of the firm has been decreasing due to the falling productivity of the operatives. As a consequence there could be a corresponding decrease in competitiveness and profitability. Management think that if a fair incentive scheme could be introduced, which was self finanacing, productivity and competitiveness should improve. Such an incentive scheme would have to be introduced carefully so that the workforce agreed with it and targets set were not related to the present levels of output.

Financial Accounting.

The firm said they had few problems with the operating of the Kalamazoo accounting system as this was a system designed for the construction industry.

Cost control of the jobs could be tightened up considerably, by assessing the profitability of each job on a monthly basis rather than on completion of the final account. The profitability of large jobs could not be worked out accurately as the margins were included in the labour rate. This made the analysis of the true costs of operations

difficult. It was reasonable to price small jobs in this way because the extra effort could not be justified.
However, the method of taking off operations, and analysing them into separate labour, plant and material cost items allowed close control of costs during construction.
The main problem was sorting out the information from the time books and invoices and allocating these costs to the operations as this would have to be a manual process.
Management would like monthly or interim control of costs of contracts carried out, but this would require too much work. The information would be inaccurate due to the late arrival of invoices for work that has been already carried been out on site, making any analysis only approximate. Subcontract, plant and materials costs were automatically checked when invoices were checked before payment. Labour costs however could not be checked against the estimated costs and some formal cost control system could help.

APPENDIX 2.

PROCESS/INPUT/OUTPUT ANALYSIS SHEETS.

LOGICAL OUTPUT PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
OUTPUT PROC NO	1.	PAGE	
NAME	OPERATION DETAILS		
OUTPUT TARGET	ESTIMATOR		
OUTPUT FORMAT	WRITTEN REPORT FOR REFERENCE.		
SOURCE DATA STORES	1.		
OUTPUT VALUES			DATA STORE
TRADE OPERATION NUMBER UNIT DESCRIPTION OUTPUT			1.

Figure A2.1.

LOGICAL OUTPUT PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
OUTPUT PROC NO	2.	PAGE	
NAME	ESTIMATES		
OUTPUT TARGET	ESTIMATOR/CONTRACTS MANAGER		
OUTPUT FORMAT	REPORT TOTALLING COSTS FOR OPERATIONS		
SOURCE DATA STORES	1, 2.		

OUTPUT VALUES		DATA STORE
CONTRACT NAME		2
ESTIMATE REFERENCE		2
TARGET SECTION		2
TRADE		2
OPERATION NUMBER		2
OUTPUT		1/2
DESCRIPTION		1
UNIT		1
QUANTITY		2
LAB. COST	Not Stored. Derived from process 1.	
PLT. COST		
MAT. COST		
SUB. COST		2
TOTALS		

Figure A2.2.

LOGICAL OUTPUT PROCESS ANALYSIS			
PROJECT	MEAT.		
DATE	12/12/84.		
OUTPUT PROC NO	3.	PAGE	
NAME	TARGET REPORTS		
OUTPUT TARGET	CONTRACTS MANAGER, OPERATIVES.		
OUTPUT FORMAT	REPORT DETAILING LABOUR DURATIONS AND TARGETS.		
SOURCE DATA STORES	1, 2.		

OUTPUT VALUES	DATA STORE
CONTRACT NAME	2
TRADE/ TARGET/ ESTIMATE REFERENCE	2
OPERATION NUMBER	2
DESCRIPTION	1
UNIT	1
OUTPUT	2
DURATION – DERIVED FROM QUANTITY, OUTPUT	2
FACTOR – INPUTTED IN INPUT 3.	
TARGET – DERIVED FROM FACTOR, DURATION.	
TOTALS – DERIVED FROM TARGETS, DURATIONS.	

Figure A2.3.

LOGICAL DATA PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
DATA TRANS NO	1.	PAGE	
NAME	CALCULATE ESTIMATES		

SOURCE VALUES	DATA STORE
CONTRACT NAME	2
ESTIMATE REFERENCE	2
TARGET SECTION	2
TRADE	2
OPERATION NUMBER	2
OUTPUT	1/2
DESCRIPTION	1
UNIT	1

TARGET VALUES	DATA STORE
LAB. COST — DERIVED FROM QUANT, OUTPUT, LAB. RATE	2
PLT. COST — " " ", PLT. RATE	2
MAT. COST — " " ", MAT. RATE	2
SUB. COST —	2
TOTALS — DERIVED FROM COSTS	

Figure A2.4.

LOGICAL DATA PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
DATA TRANS NO	2.	PAGE	
NAME	CALCULATE TARGETS AND DURATIONS.		

SOURCE VALUES	DATA STORE
CONTRACT NAME	2
TRADE/TARGET/ESTIMATE REFERENCE	2
TRADE	2
OPERATION NUMBER	2
OUTPUT	2
QUANTITY	2
FACTOR – Not Stored. Inputted from 3.	
MANAGEMENT/OPERATIVE SHEET – " — .	

TARGET VALUES	DATA STORE
CONTRACT NAME	
TRADE/TARGET/ESTIMATE REFERENCE	
MANAGEMENT/OPERATIVE SHEET.	2
OUTPUT	
DURATION	
FACTOR	
TARGET	
TOTALS	

All derived, not stored.

Figure A2.5.

LOGICAL INPUT PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
INPUT PROC NO	3.	PAGE	
NAME	TARGET DETAILS		
INPUT SOURCE	CONTRACTS MANAGER		
TARGET DATA STORES	2, 3		

INPUT VALUES	DATA STORE
CONTRACT NAME ESTIMATE REFERENCE TRADE/TARGET/ESTIMATE REFERENCE MANAGEMENT/OPERATIVE SHEET FACTOR No values are stored, used to derive information.	

Figure A2.6.

LOGICAL INPUT PROCESS ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
INPUT PROC NO	1.	PAGE	
NAME	OPERATION DETAIL MAINTENANCE		
INPUT SOURCE	STANDARD OUTPUTS, PRICE BKS, FEEDBACK FROM SITE.		
TARGET DATA STORES	1.		

INPUT VALUES	DATA STORE
TRADE	1
OPERATION NUMBER	1
UNIT	1
DESCRIPTION	1
OUTPUT	1

Figure A2.7.

LOGICAL DATA STORE ANALYSIS					
PROJECT	MEAT				
DATE	12/12/84				
DATA STORE NO	1.	PAGE			
NAME	STANDARD OPERATION DETAILS				
VALUE NAME		TYPE (9/X)	CHARS	INT PLACES	DEC PLACES
TRADE		X	4		
OPERATION NUMBER		9	3	3	
UNIT		X	4		
DESCRIPTION		9/X	60		
OUTPUT		9	6	3	2

Figure A2.8.

LOGICAL DATA STORE ANALYSIS			
PROJECT	MEAT		
DATE	12/12/84		
DATA STORE NO	2.	PAGE	
NAME	ESTIMATE		

VALUE NAME	TYPE (9/X)	CHARS	INT PLACES	DEC PLACES
CONTRACT NAME	X	4		
TRADE	X	4		
OPERATION NUMBER	9	3	3	
ESTIMATE REFERENCE	9	4	4	
TARGET SECTION	X	4		
OUTPUT	9	6	3	2
QUANTITY	9	8	5	2
LAB. RATE.	9	8	5	2
PLT. RATE	9	8	5	2
MAT. RATE	9	8	5	2
SUB. RATE	9	8	5	2

Figure A2.9.

APPENDIX 3.

ANALYSIS OF OUTPUT DATA.

Firms involved in the research, built up labour rates for estimates based on a mixture of experience and reference to price books, when the work was outside their experience. The information in the price books was only used as a guide to help the estimator form a rough idea of the work involved. As all the builders used price books to help with estimating, their possible use for building up performance outputs was tested.

Outputs used by the firms themselves could not be used as they did not want open use or wish to reveal their own outputs for reasons of confidentiality.

Certain problems were identified by the collaborating firms, if price books were used to build up outputs;

i) Firms consulted more than one book when working out a price. The final price was based on the books figures and the estimator's experience.

ii) Firms claimed that for certain sections of work the prices in the books were ridiculous ie. It was stated that the breaking up of concrete slabs was upto a factor of three out.

iii) Depending on whether they were estimating or making claims, different books were used due to different price levels in them.

iv) Different books were used by different firms.

The firms were quite happy to use a database whose output information was based on pricebooks, the problem was to find out which book or combination of books held reliable data. An initial study of the price books was undertaken to assess their accuracy. Five books were taken for comparison and from each book three trades looked at; brickwork, excavation and carpentry. Similar items in each book were then identified and their rates noted. A number of conclusions were drawn from a subjective comparison of the rates:-

i) For similar items, there were large differences in the rates between books.

ii) Labour costs, conditions and the method for building up the rates differed between the books. This fact could explain for part of the variation between the rates.

iii) Some items had a large variation in their rates between the books; sometimes a factor of three was observed. For comparison purposes, some of these variations could be taken out by analysing the basic time to complete an item of work.

iv) The build up of the labour content for certain operations seemed illogical. For example roof joists; the price per unit length was proportional to the cross sectional area; as the area doubled so did the price. This seems illogical as a roof joist usually has two fixing points, either end. As the cross sectional area doubles, the span of the joist would increase and still need two fixing points. In my opinion the price for fixing a joist of double the area, per unit length, would not be double. Other examples such as this were also identified.

v) When analysed subjectively the information held in the price books did not seem to be realistic or accurate and therefore of little use in building up an accurate databank for estimating.

To accurately assess the difference between the price books, they had to be tested objectively using statistics. The mean and standard deviations of the outputs for each book and trade was calculated to show the mean value and how the rates were spread about the mean.

The data was then grouped together and analysed as one set, rather than individual books, using the analysis of variance formula.

The first task was to adjust all the data available, in an attempt to remove the difference in building up prices between the books.

All the books stated that the final rates were average figures based on average conditions. However, the basic information for calculating these rates varied between the books. To remove this variation, the hours taken to complete an item of work were tested and not the prices. This automatically cut out a number of price books as they did not print the labour outputs, and they could not have been calculated without a great deal of effort.

In total, four books gave an output in terms of hours for operations. (Comprehensive Book Of Rates:1984, Griffiths:1984, National Schedule Of Rates:1983, Spons:1984) The trades tested, reinforcement, concreting, excavation and carpentry were ones which the builders estimated themselves rather than those usually subcontracted out to be priced.

Items were then identified which were identical in work content and conditions to make the comparison valid, otherwise the observed differences could be attibuted to the different work contents. Some trades had to ruled out of the study here as the number of similar items were too small, for example brickwork.

Once the data was collected, various tests were performed.

A number of assumptions had to be made about the sets of data first, for the tests to be valid.

It was assumed that for each item the output given in hours was an average figure, taken from a normally distrubuted population. This held true, as the books stated that the outputs were all based on average costs and conditions.

Operations were only included if each book noted an output for it. The overall affect of this method of acceptance was assumed to make the choice of operations random.

The arithmetic mean of the outputs for each book was calculated. The arithmetic mean for outputs in each trade and each book would not be meaningful, as each operation's output in a trade was not related to any other and their range was large. For example excavation, the affect of the operations with low output figures (Level and compact, output 0.05 hrs) would be minimal on the mean. To avoid this error, a relative output for each book's item was calculated, based on a mean output of 100 for each item. Each item's outputs were averaged, then each book's output expressed as a percentage of the average for each separate item. (Ashworth:1980)

For example Spons-0.8; Griffiths-0.9; Compre-1.1; Sched-1.2 hrs.

Mean output =1.0=100. Relative output $= \frac{\text{Actual Output}}{\text{Mean Output}} * 100$

Relative output=Spons-80; Griffiths-90; Compre-110; Schedule-120.

Whole trades were meaningfully compared using these relative outputs.

The arithmetic mean was calculated from

Mean = (Total sum of rel.outputs)/Number of outputs.

(Chatfield:1983)

As this was done for each book and trade, comparisons were easily made between them.

To analyse the spread of the data about the mean, the standard deviation was calculated.

The relative outputs were used to calculate the standard deviation.

The standard deviation was calculated from

$$SD = \sqrt{\frac{\text{(Output - Mean)*2}}{\text{Number of outputs -1}}}$$ (Chatfield:1983).

(Output - Mean)*2

The mean and standard deviation formula only compared the outputs for separate books. To look at the data as one set, the analysis of variance was used.

The test was used to see whether there was any appreciable variation between the books. As there were two variables, namely books and items, a test based on a two way crossed classification without replication was required. The test was suitable for this data as it tested for the significance of the variance caused by both the different operations and books. The test did not need replication as there was only one output value for each book and item.
(Bennett and Franklin:1967)
The test calculated the variation between the books, between the types of items and a residual variation.
To test for the significance of the results, an 'F test' was performed on the calculated variances. The significance level for the F tests was taken to the .05 significance level.
The null hypothesis tested, was that there was no significant difference between the means.

TRADE: Concreting Number of operations:16

DESCRIPTION	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
Founds, < 300mm deep.	1.5	1.7	1.0	1.9
" , 150-300mm deep.	1.9	1.9	1.3	2.2
Isolated base, > 300mm. deep.	2.0	2.0	1.5	2.2
Fill hollow wall.	4.5	4.35	3.8	4.35
Beds 150-300mm.	1.7	2.6	1.0	3.05
" 100-150mm.	2.4	3.5	1.5	3.3
" < 100mm.	3.0	3.9	2.0	3.55
Suspended slab, 100-150mm.	4.0	8.4	3.0	4.1
Upstand, kerb, <0.03m.2. area.	5.4	9.6	7.0	6.3
Wall, 150-300mm thick.	3.85	8.6	2.9	4.65
" , 100-150mm thick.	4.4	8.9	3.3	5.0
Steps, stairs.	7.0	8.7	4.0	7.5
Columns, 0.03-0.15m.2. area.	7.0	9.4	5.5	7.35
< 0.03m.2. area.	8.0	10.8	6.0	9.45
Beams, 0.03-0.1m.2. area.	6.0	9.0	4.0	5.05
< 0.03m.2. area.	7.0	10.2	5.5	6.5

	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
MEAN	92.7	132.5	68.6	106.1
S.D.	10.1	22.7	12.8	17.4

<u>ANOVA TABLE.</u>

Source of Variation	Sums Of Squares	D.F.	Mean Square	F. Ratio.
BOOKS	82.16	3	27.386	25.26
ITEMS	322.261	15	21.484	19.81
RESIDUAL	48.79	45	1.08	
TOTAL	453.211	63		

From tables,
Fb .05,3,45=2.84 Ft .05,15,45=1.92 Both significant.

TRADE: Excavation Number of operations:35

DESCRIPTION.	SPONS	GRIFFITHS	COMPRE.	NAT. SCHED.
Breakout				
Tarmac, hand, 50-75mm.	0.40	0.80	0.16	0.50
Plain conc, hand,				
150mm. thick.	0.70	2.40	1.05	1.20
Compressor, soft rock.	3.00	3.00	5.90	3.63
all less , plain conc.	4.50	5.00	7.00	6.63
0.25m deep. reinf conc.	6.00	7.50	10.00	10.13
Excavate by hand,				
Reduce level,				
< 0.25m. deep.	1.8	3.0	2.9	2.6
< 1.00m. deep.	2.0	3.3	3.0	2.4
< 2.00m. deep.	2.2	4.8	3.2	2.2
Exc. pits, < 0.25m deep	3.0	4.3	3.0	5.5
< 1.0m. deep.	3.0	4.6	3.3	5.0
< 2.0m. deep.	3.5	5.9	5.0	6.8
Exc. pits, <1.25*1.25m.				
< 1.0m. deep.	3.6	6.15	3.5	7.6
< 2.0m. deep.	4.2	7.45	3.3	10.2
Exc. trench,				
<0.3m wide <0.75m deep.	0.65	1.16	0.79	1.0
>0.3m wide <0.25m deep.	2.5	3.6	3.0	3.6
>0.3m wide <1.0m deep.	2.5	3.9	3.3	3.2
>0.3m wide <2.0m deep.	2.9	5.2	5.0	4.3
Exc, fill hand, compact.				
Pits, < 0.25m. deep.	3.5	5.25	5.2	7.13
" , < 1.0m. deep.	3.5	5.85	5.6	6.95
" , < 2.0m. deep.	3.9	7.40	8.4	8.83
Trench, < 0.25m. deep.	4.6	4.6	4.2	5.13
" , < 1.0m. deep.	4.6	5.15	4.5	5.28
" , < 2.0m. deep.	5.2	6.7	6.7	6.62
Level and compact.	0.05	0.05	0.08	0.2
Deposit, spread, level,				
compact spoil. <50m.				
transfer.	1.3	2.5	2.9	3.3
Load lorries by hand.	1.0	1.65	1.85	2.4
Filling				
Earth	1.0	1.25	1.2	1.63
Hardcore, compress in				
250mm. layers.	0.7	2.0	2.65	2.4
Hardcore, 100mm. deep.	0.1	0.3	0.33	0.35
" , 150mm. deep.	0.15	0.4	0.46	0.45
" , 200mm. deep.	0.2	0.55	0.58	0.46
Blind hardcore, sand.	0.08	0.07	0.13	0.10
Earthwork support to				
trenches.				
Sides < 2.0m apart.				
< 1.0m. deep.	0.15	0.4	0.35	0.6
< 2.0m. deep.	0.19	0.45	0.39	0.75
< 4.0m. deep.	0.24	0.55	0.72	0.77

	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
MEAN	65.7	109.9	102.1	122.3
S.D.	16.6	24.0	24.1	26.3

ANOVA TABLE.

Source of Variation	Sums Of Squares	D.F.	Mean Square	F. Ratio.
BOOKS	43.712	3	14.57	17.70
ITEMS	738.711	34	21.73	26.39
RESIDUAL	83.968	102	0.82	
TOTAL	866.391	139		

From tables,
Fb .05,3,102=2.75 Ft .05,34,102=1.59 Both significant.

TRADE: Fabric Reinforcement Number of operations:11

DESCRIPTION	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
A142	0.09	0.16	0.03	0.09
A193	0.12	0.18	0.04	0.09
A252	0.13	0.21	0.04	0.09
B283	0.12	0.21	0.04	0.09
B385	0.13	0.23	0.04	0.11
B503	0.15	0.27	0.05	0.11
C283	0.10	0.17	0.04	0.09
C385	0.12	0.19	0.04	0.09
C503	0.13	0.22	0.04	0.09
D49	0.25	0.50	0.04	0.14
D98	0.25	0.50	0.04	0.14

	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
MEAN	105.6	184.0	31.7	78.7
S.D.	4.6	16.4	7.5	11.3

ANOVA TABLE.

Source of Variation	Sums Of Squares	D.F.	Mean Square	F. Ratio.
BOOKS	0.278	3	0.092	31.62
ITEMS	0.098	10	0.001	3.34
RESIDUAL	0.088	30	0.003	
TOTAL	0.464	43		

From tables,
Fb .05,3,30=2.92 Ft .05,10,30=3.33 Both significant.

TRADE: Carpentry Number of operatios:41

DESCRIPTION	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
Carcassing, softwood.				
Floor joists, 50*100mm.	0.14	0.08	0.12	0.14
" , 50*150mm.	0.15	0.09	0.13	0.23
" , 50*200mm.	0.16	0.11	0.14	0.27
" , 75*150mm.	0.16	0.12	0.15	0.32
Partitions, 50*75mm.	0.52	0.33	0.24	0.23
" , 50*100mm.	0.65	0.35	0.24	0.28
Roof joists, 25*150mm.	0.15	0.15	0.13	0.16
" , 38*100mm.	0.15	0.16	0.15	0.16
" , 50*100mm.	0.18	0.20	0.19	0.23
" , 75*100mm.	0.25	0.30	0.28	0.48
" , 75*150mm.	0.25	0.45	0.40	0.48
Kerbs, 50*100mm.	0.07	0.12	0.17	0.11
Struts, 50*175mm.	0.30	0.50	0.33	0.26
First fix.				
Chipboard, 18mm t/g.	0.32	0.33	0.75	0.45
" , 25mm t/g.	0.35	0.40	0.75	0.52
Roofboard, butt joint,				
19mm flat fall.	0.45	0.65	0.55	0.45
19mm slope.	0.50	0.80	0.60	0.50
25mm flat fall.	0.45	0.67	0.55	0.48
25mm slope.	0.50	0.84	0.60	0.57
Firring, 50*38mm.	0.15	0.06	0.08	0.21
" , 50*50mm.	0.15	0.07	0.09	0.23
" , 50*63mm.	0.15	0.08	0.10	0.23
Bearer, 38*50mm.	0.10	0.12	0.14	0.16
" , 50*50mm.	0.10	0.13	0.15	0.16
" , 50*75mm.	0.10	0.15	0.17	0.16
Shiplap, 19mm.	0.65	0.65	0.55	0.70
" , 25mm.	0.75	0.70	0.55	0.73
Softwood 25mm, t/g				
floor. -100mm wide.	0.65	1.15	0.75	0.80
" . -150mm wide.	0.55	0.75	0.75	0.80
19mm t/g 'V' to wall.	0.80	0.80	0.62	0.70
Second fix.				
Skirting, 19*100mm.	0.10	0.33	0.48	0.24
" , 25*150mm.	0.12	0.35	0.56	0.29
Quadrant, 19mm.	0.05	0.10	0.18	0.16
" , 25mm.	0.05	0.11	0.20	0.16
Stops, 19*38mm.	0.10	0.15	0.25	0.18
" , 25*38mm.	0.10	0.15	0.28	0.18
" , 25*50mm.	0.10	0.16	0.30	0.21
Glazing beads,				
13*19mm.	0.05	0.17	0.28	0.21
13*25mm.	0.05	0.14	0.20	0.21
13*32mm.	0.05	0.10	0.17	0.21
19*32mm.	0.05	0.10	0.18	0.23

	SPONS	GRIFFITHS	COMPRE	NAT. SCHED.
MEAN	79.4	94.0	110.6	115.9
S.D.	32.2	23.5	31.9	29.0

ANOVA TABLE.

Source of Variation	Sums Of Squares	D.F.	Mean Square	F. Ratio.
BOOKS	0.136	3	0.045	4.58
ITEMS	7.296	40	0.182	18.37
RESIDUAL	1.190	120	0.01	
TOTAL	8.622	143		

From tables,
Fb .05,3,120=4.6 Ft .05,40,120=18.39 Both significant.

CONCLUSIONS.

The mean values for all the trades differed greatly. The minimum diifference of the means occurred in carpentry, where it ranged from 79.4 to 115.9. The maximum range of 152.4, 31.7 to 184.0 occurred in fabric reinforcement. None of the books had the highest or lowest mean in all the trades.

The standard deviations were all large except in fabric reinforcement which indicated a large spread in the data. There was no pattern between the books standard deviations for different trades.

Looking at the tests together, the output data for each book, in each trade was variable in both mean and spread. No consistent relationships, except for variability could be seen to exist in the data.

When the data was grouped together, and the books tested for variance a number of conclusions were made.

There was as expected, a significant variation between the types of items for one trade and for the source between the books.

For all the trades studied, the "F" values were significant for the source between the books.

APPENDIX 4.

DEVELOPMENT OF MEAT AND A DATABASE OF OPERATIONS.

4.1. INITIAL DATABASE SENT TO FIRMS FOR DISCUSSION.
4.2. FINAL INDEXED DATABASE OF OPERATIONS.
4.3. ESTIMATE FOR LABOUR COSTS ONLY.
4.4. FINAL CONTRACT DOCUMENTS AND TYPICAL REPORTS PRODUCED FROM 'MEAT'.

APPENDIX 4.1.

INITIAL DATABASE SENT TO FIRMS FOR DISCUSSION.

OPERATION-PRELIMS	UNITS
Van	Week
Lorry-type	Week
Store shed-m. sq	Week
Compound-m. sq.	Week
Erect 2.4m high chainlink fence and posts.	m.
Erect 2.4m high hoarding.	m.
Scaffold-Quickstage-m. sq.	Week
-Tube & fixings-m. sq.	Week
Crane hire-type	Day
Small tools	Month
Insurances	£
Attendance-S.C.s.	£
Contractors obligations	£
Connections for services.	£
Water charges.	£
Electricity charges.	£
Gas charges.	£
Protection to external wall-Polythene-	m.sq.
Protection to internal rooms.	m.sq.
Temporary support to floor or jambs-Acrows-	number.

OPERATION-EXCAVATION	UNITS
Clear site rubble,low vegetation ,machine	m.sq.
Grub up hedge, bush every m., less than 2m.-HAND-	m.
tall. -MACH-	m.
Breakout-Brickwork	m.cube.
-Mass concrete	m.cube.
-75mm.reinforced concrete slab	m.cube.
-150mm. " " "	m.cube.
-250mm. " " "	m.cube.
-75mm. unreinforced concrete slab	m.cube.
-150mm. " " "	m.cube.
-250mm. " " "	m.cube.
-asphalt	m.sq.
-paving flags	m.sq.
Excavate small pits by hand for posts etc.	m.cube.
Excavate large pits/bases, areas by hand <2m dp-	m.cube.
->2m deep-	m.cube.
Excavate trenches by hand.	m.cube.
Excavate bases, pits, etc. machine-<3m deep-	m.cube.
Excavate trenches, machine-<2m wide-<2m deep-	m.cube.
-<2m wide->2m deep-	m.cube.
Excavate reduced dig machine-<150mm deep-	m.cube.
->150mm deep-	m.cube.
Plank and strut to excavation every 1m, allow for reuse of timber.-Support sides of trench.-	m.sq.
-Support side of basement.-	m.sq.

OPERATION-EXCAVATION	UNIT
Muckaway spread on site -hand-	m.cube.
-machine-	m.cube.
Muckaway load directly onto 10t lorry to tip.	m.cube.
Backfill and compact earth, barrow by hand, compact by whacker plate.	m.cube.
Backfill and compact earth, JCB and roller.	m.cube.
Place and compact hardcore in 250mm layers.	m.cube.
Place and compact crushed concrete in 250mm layers.	m.cube.
Landscape area with topsoil.	m.cube.

OPERATION-DRAINAGE-	UNIT
Grub up obsolete drainage-size-	m.
Grub up obsolete manholes-size-	number.
Seal off disused branch.	number.
Grade bottom of trench, lay all drainage between manholes, include for bends, branches etc.	
-Clay-100mm-	m.
-Clay-150mm-	m.
-UPVC-	m.
-Cast iron-	m.
Surround drain with concrete.	m.cube.
Install gullies and traps-type-	number.
External manhole drain connections-type-	number.
Internal manhole drain connections-type-	number.
Locate drain runs and test.	number.
Locate fault, repair pipe.	number.
Rodout and clear drains.	m.
Cement mortar joints.	number.
Build manhole with concrete rings-size-	m.
Finish off base of manhole with 3&1 or grano.	m.sq.

OPERATION-CONCRETE	UNIT
Concrete 1:3:6 mixed on site, mixer.	m.cube.
Concrete 1:3:6 mixed on site by hand.	m.cube.
Place concrete in trench, vibrate, tamp finish to levels.-Direct tip-	m.cube.
-Dumper/ tip-	m.cube.
-Barrow-	m.cube.
Place concrete in pad/base, vibrate, tamp finish to levels.-Direct tip-	m.cube.
-Dumper/ tip-	m.cube.
-Barrow-	m.cube.
Sand blind areas.	m.sq.
Lay polythene sheets.	m.sq.
Place concrete in slabs, vibrate, place mesh reinf, finish to surface.Direct tip-150mm-	m.cube.
-250mmm-	m.cube.
-Dumper/Barrow.-150mm-	m.cube.
-250mm-	m.cube.

OPERATION-CONCRETE	UNIT
Set road forms, lay sand, polythene, direct tip, tamp finish, strike forms.-<150mm.thick-	m.cube.
-150mm.thick-	m.cube.
Lay blinding concrete, spread & finish with shovel transfer by machine.	m.cube.
Rough slabs for manholes, gullies, transfer by machine, spread &compact by hand.	m.cube.
Haunching for kerbs, concrete tipped directly into heaps then placed and shaped by hand.	m.cube.
Place concrete in kickers and compact.	m.cube.
Hoist and barrow 40m. using 3 labourers.	m.cube.
Place concrete in column-Hard/Easy	m.cube.
Place concrete in beam -Hard/Easy	m.cube
Place concrete in reinforced floor slab-Hard/Easy	m.cube.
Place concrete in formwork using crane and 1m. cube skip.	m.cube.

OPERATION-FORMWORK	UNIT
Foundation pad/base-system-	m.sq.
-made up ply-	m.sq.
Ground beams.	m.sq.
Retaining walls.	m.sq.
Columns-<2.4m high-<0.2m. sq.-	m.sq.
Columns->2.4mhigh->0.2m. sq.-	m.sq.
Walls.	m.sq.
Liftshaft.	m.sq.
Staircase.	m.sq.
Downstand beams.	m.sq.
Slabs-Flat-	m.sq.
-Trough/rib system-	m.sq.
Upstands off slab.	m.sq.
Small, awkward pieces.	m.sq.
Stopends-Heavy steel-	m.sq.
-Light steel-	m.sq.
Water bar-Horizontal-	m.
-Vertical-	m.
Kickers.	m.sq.
Fix clips, ties, fastenings to formwork.	number.
Make, fix, strike boxes for slab, column.	m.sq.
Make, fix polystyrene shapes to formwork.	number.
Make, fix, strike kicker-Off slab-	m.sq.
-Hanging kicker-	m.sq.
Formwork concreted in-Extra over-	m.sq.
Rough formwork for any work.	m.sq.

OPERATION-REINFORCEMENT	UNIT
Fix mesh in slab-type-	Ton
Cut and bend mesh and fix-type-	Ton
Fix mesh surround to columns and beams-type-	Ton
Cut and bend steel to schedules-12mm-	Ton
-25mm-	Ton
Cut and bend mild steel links, stirrups	Ton
Fix, tie, space scheduled steel-Slab-12mm-	Ton
-Slab-25mm-	Ton
-Colm-12mm-	Ton
-Colm-25mm-	Ton
-Beam-12mm-	Ton
-Beam-25mm-	Ton
Fix steel in difficult conditions-high density-	Ton
Fix small quantities of steel	Ton

OPERATION-BRICK AND BLOCKWORK	UNIT
Mix mortar in mixer, transfer 30m by labourer.	m.cube.
Distrubute bricks < 30m from pallet by barrow.	number
Build one brick wall, pointing-Facings-	m.sq.
-Commons/engineering	m.sq.
Build half brick wall, pointing-Facings-	m.sq.
-Commmons/engineering	m.sq.
Thermalite block -100mm-	m.sq.
-150mm-	m.sq.
Concrete block-100mm-	m.sq.
-150mm-	m.sq.
Build cavity wall-allow for brick face, ties, blocks, insulation, frames, dpm, lintols.	m.sq.
Substructure-2 skins of engineering, fill cavity.	m.sq.
-one brick wall-	m.sq.
-cavity wall-	m.sq.
-sleeper wall-	m.sq.
-underpinning in short lengths-	m.
Rake out decayed joint and repoint.	m.sq.
Rake out sound joint and repoint.	m.sq.
Rake out chimney breast and repoint, allow access.	m.sq.
Take down & recover old wall, half brick, rebuild.	m.sq.
Small or difficult brickwork half brick.	m.sq.
Tie half brick wall to existing building.	m.
Tie 100mm block wall to existing building.	m.
Breakout hole through 105mm. brick.	m.sq.
Breakout hole through 215mm. brick.	m.sq.
Break hole through cavity wall.	m.sq.
Temporary support to hole in wall-<2m sq.-	m.sq.
->2m.sq.-	m.sq.
Temporary support to ceiling.	m.sq.
Build in new lintol to opening-Half brick-	m.
-Brick-	m.
-RSJ-size-	m.
Make good jambs of hole for frame.	m.
Build in metal sashes or lugs-<2m. sq.-	m.sq.
->2m. sq.-	m.sq.
Fix new fireplace or hearth-size-	number.
Knockout old chimney breasts, remove all material makegood wall.	m.sq.
Seal top of chimney, allow for access.	m.sq.
Cutout decayed bricks, replace with new ones.	m.sq.
Repair fractures, lace in new brickwork to old solid brickwork-Half brick-	m.
-Brick-	m.
Rough cutting for pipes, cables.-thermalite block-	m.
-concrete block-	m.
-brick-	m.
Repoint hips and ridges to roof.	m.
Scaffolding by labourer-trestles-	m.
-quickstage-	m.
Independant scaffold.	m.

OPERATION-JOINERY AND CARPENTRY-Structural	UNIT
Erect post and rail fence-size-	m.sq.
Fix slatted gate-size- and posts.	number.
Fix wall plate-sizes-	m.
Fix joists-sizes-	m.
Fix rafters-sizes-	m.
Fix purlins-sizes-	m.
Fix softwood T & G floorboards-type-	m.sq.
Fix small quantities of T & G to repair old floor.	m.sq.
Fix 18mm quality chipboard flooring.	m.sq.
Fix gang nailed roof trusses-sizes-	number.
Fix struts/binders/hangers.	m.
Erect new partition-sizes- softwood-	m.sq.
Taking down old partitions-type-	m.sq.
Taking down/out defective-joists/rafters	m.
-floorboards-	m.sq.
-purlins-	m.
-staircase/straight-	m.
-staircase/dogleg-	m.
Prepare old timber for use again-joists/rafters	m.
-floorboards-	m.sq.
-purlins-	m.
Removing old frames-<2m.sq.-	number
->2m.sq.-	number.
Cut hole in T & G floor and build in new hatch.	m.sq.
Take up defective T & G flooring relay, making good with new softwood flooring.	m.sq.
Cut holes in partitions-timber, for pipes-sizes-	number.

OPERATION-JOINERY AND CARPENTRY-Roofwork	UNIT
Fix 18mm chipboard to roof.	m.sq.
Fix 50mm woodwool slabs.	m.sq.
Fix T & G boarding-sizes-	m.sq.
Fix 18mm quality chipboard-T & G-	m.sq.
-Plain-	m.sq.
Fix 100mm quilt insulation.	m.sq.
Fix fascia board-sizes-	m.
Fix soffit board-sizes-	m.
Fix barge board-sizes-	m.
Fix roof rafters-sizes-	m.
Fix gang nailed trusses-sizes-	number.
Fix roof joists-sizes-	m.
Fix roof felt and battens.	m.sq.
Fix rain water gutter and clips-type-	m.
Fix down pipes-type-	m.
Fix outlets	number
Fix VELUX window-sizes-allow for all associated work to roof.	m.sq.
Take off slates and store.	m.sq.
Take off battens and roofing felt.	m.sq.
Take down roof timbers-sizes-	m.
Take down soffit/barge/fascia boarding.	m.sq.
Construct platforms for storage tanks-type-	m.sq.

OPERATION-JOINERY AND CARPENTRY-1st fix	UNIT
Secure windows frames in position.	number.
Secure internal door lining and stop fillets.	number.
Secure external door lining and stop fillets.	number.
Fix window boards-sizes-	m.sq.
Fix thresholds and cills-sizes-	m.sq.
Fix grounds to wall for plaster-sizes-	m.
Fix timber by plugging to brickwork-sizes-	m.
Fix pipe boards-sizes-	m.
Fix studwork-sizes-	m.sq.
Fix weather boarding-sizes-	m.sq.
Fix storm guard-sizes-	m.
Take out old door and reline frame.-type-	number.

OPERATION-JOINERY AND CARPENTRY-2nd fix-	UNIT
Fix internal door-sizes-	number.
Fix external door-sizes-	number.
Square up old doors-type-	number.
Fix straight stair case.	number.
Fix dogleg stair case.	number.
Fix balustrade.	m.
Resecure and strengthen handrail and balustrade.	m.
Fix handrails for stairs.	m.
Vertical ducting.	m.sq.
Fix architrave-type-	m.
Fix skirting-type-	m.
Fix pipe boxing.	m.sq.
Fix wall units-size-	number.
Fix tall units-size-	number.
Fix floor units-size-	number.
Fix sink units without sink.-size-	number.

OPERATION-JOINERY AND CARPENTRY-Ironmongery	UNIT
Fix lock and handles-type-	number.
Fix letter box/flaps etc.	number.
Fix bolts-Surface-	number.
Fix cupboard catches-types-	number.
Fix overhead gear.	number.
Glaze window, putty etc.	m.sq.
Glaze window beads etc.	m.sq.

APPENDIX 4.2.

FINAL INDEXED DATABASE OF OPERATIONS.

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
BLR		95	0.00		
BLR		8	0.33	M	CUT UP VERGES IN CAVITY WALL
BLR		82	0.70	M	CUT TOOTH AND BOND 100 BLOCKWORK TO EXISTING BRICK WALL
BLR		88	0.10	M	FIX WALL PLATE
BLR		92	0.33	M	RAKE OUT JOINT & POINT VERGE
BLR		85	1.35	M	RSJ 178 X 102 X 21.54 & HOIST & FIX OVER OPENING
BLR		97	1.00	M.	CUT TOOTH AND BOND.
BLR		25	1.00	M.SQ	100 BLOCKWORK IN PARTITIONS AND INNER LEAF OF CAVITY WALL
BLR		94	3.00	M.SQ	BLOCK UP WINDOW OPENING 1ST FLOOR LEVEL (1+1)
BLR		6	2.56	M.SQ	BRICKWORK IN CAVITY WALL IN FOUNDATIONS
BLR		91	4.00	M.SQ	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL
BLR		81	2.74	M.SQ	CAVITY WALL ABOVE DPC OF BRICK & BLOCK WALLS & INSULATION
BLR		20	1.28	M.SQ	HALF BRICK WALL IN FOUNDATIONS (2+1)
BLR		83	1.28	M.SQ	HALF BRICK WALL IN SUPERSTRUCTURE
BLR		90	1.50	M.SQ	HALF BRICK WALL IN FILLING OPENINGS UP TO 1 SQ.M
BLR		96	1.50	M.SQ	HALF BRICK WALL IN FILLING OPENING.
BLR		59	1.00	M.SQ	LAYING 900X600 PAVING FLAGS ON CONCRETE PAVING
BLR		93	2.90	M.SQ	ONE BRICK WALL FACED BOTH SIDES
BLR		29	0.15	M.SQ	UNLOADING BRICK & WHEEL UP TO 20 M, HALF BRICK OR BLOCK WALL
BLR		89	1.00	NO	PADSTONES & BUILD INTO EXISTING WALL
BLR	BSUP	84	0.50	NO	BUILD IN ANCHOR BLOCKS
BLR	FLRS	39	1.75	M.SQ	LAY QUARRY TILES
BLR	MATS	87	0.00	NO	SUPPLY AIRBRICKS
BLR	PAVE	43	0.33	M.SQ	EXTRA FOR FAIR FACED BRICKWORK
BLR	SUBS	23	2.56	M.SQ	ONE BRICK WALL IN FOUNDATIONS
BLR	SUBS	30	0.30	M.SQ	WHEELING UP TO 20M, 1 BRICK WALL
BLR	SUBS	31	0.45	M.SQ	WHEELING UP TO 20M, 1½ BRICK WALL
BLR	SUBS	32	0.20	M.SQ	WHEELING UP TO 40M, HALF BRICK OR BLOCK WALL
BLR	SUBS	33	0.40	M.SQ	WHEELING UP TO 40M, ONE BRICK WALL
BLR	SUBS	34	0.80	M.SQ	WHEELING UP TO 40M, 1½ BRICK WALL
BLR	SUBS	37	2.00	NO	FORM HOLE IN CAVITY WALL OR 1 BRICK WALL & BUILD IN A.G
BLR	SUBS	38	0.50	NO	FORM HOLE IN BRICK OR BLOCK WALL TO RECEIVE ENDS OF JOISTS
BLR	SUPS	42	1.50	M	BEAM FILLING TO ONE BRICK OR CAVITY WALL
BLR	SUPS	72	0.50	M	BED AND POINT PRECAST CONCRETE COPING
BLR	SUPS	35	0.25	M	BRICK ON EDGE COPING TO ONE BRICK WALL
BLR	SUPS	40	0.50	M	CUT TOOTH & BOND HALF BRICK WALL TO EXISTING
BLR	SUPS	41	1.00	M	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING
BLR	SUPS	44	0.50	M	CUTTING TO VERGES
BLR	SUPS	51	0.10	M	POINT FLASHING
BLR	SUPS	55	0.10	M	PREPARING BRICKWORK FOR RAISING HALF BRICK OR BLOCK
BLR	SUPS	56	0.15	M	PREPARING BRICKWORK FOR RAISING - ONE BRICK & CAVITY WALL
BLR	SUPS	50	0.15	M	RAKE OUT JOINT FOR FLASHING
BLR	SUPS	71	1.00	M	REFIX CONCRETE OR STONE CILL
BLR	SUPS	52	2.80	M	REMOVE BRICKS IN SHORT LENGTHS INSERT CAV.TRAY & MAKE GOOD
BLR	SUPS	60	1.00	M	TAKE OUT STONE OR CONCRETE SILL
BLR	SUPS	57	0.50	M	TYING PANELS TO EXISTING BRICKWORK WITH METAL TIES-½ BRICK
BLR	SUPS	58	1.00	M	TYING PANELS TO EXISTING WALLING - ONE BRICK & CAVITY WALLS
BLR	SUPS	27	2.14	M.SQ	ART STONEWORK IN HALF BRICK AND CAVITY WALLS (INC. JUMPERS)
BLR	SUPS	26	1.67	M.SQ	ART. STONE IN HALF BRICK WALLS AND CAVITY WALLS(NO JUMPERS)
BLR	SUPS	73	0.25	M.SQ	CAVITY WALL INSULATION - JABLITE OR SIMILAR
BLR	SUPS	80	1.52	M.SQ	HALF BRICK WALL IN FACINGS IN OUTER LEAF OF CAVITY WALL(2+1)

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
BLR	SUPS	24	2.56	M.SQ	ONE BRICK WALL ABOVE GROUND LEVEL
BLR	SUPS	53	1.25	M.SQ	RAKE OUT JOINTS & POINT BRICKWORK - SOFT MORTAR
BLR	SUPS	54	1.75	M.SQ	RAKE OUT JOINTS AND POINT BRICKWORK - HARD MORTAR
CARC		1	0.20	M	SOFFIT TO BARGE BOARD
CARP		748	0.50	M	100 X 50 BEARER SECURED TO.WALL AS SUPPORT FOR JOIST
CARP		746	0.75	M	225 WIDE SHELVING INCLUDING BEARERS & BRACKETS
CARP		745	0.50	M	CAPPING TO TIMBER PANEL
CARP		752	0.55	M	FILLING RECESSES TO SQUARE OFF JAMBS
CARP		6	0.18	M	FIRST FLOOR JOISTS
CARP		726	0.18	M	FIRST FLOOR JOISTS
CARP		737	14.00	M	FIX VELUX ROOFLIGHT & FLASHING(BASED ON PERIMITER OF ROOFL'T
CARP		755	0.50	M	FIX HANDRAIL
CARP		733	1.00	M	MAKE GOOD FLOOR OR CEILING WHERE PARTITION REMOVED
CARP		729	0.20	M	SOFFIT TO BARGE BOARD
CARP		734	0.20	M	STUD PARTITION
CARP		723	0.36	M	TAKE OFF GUTTER FASCIA & SOFFIT
CARP		727	0.36	M	TAKE OFF GUTTER & FASCIA
CARP		747	0.25	M	TAKE OUT FLOOR JOISTS
CARP		753	0.14	M	TAKE OFF HANDRAIL
CARP		754	0.25	M	TAKE DOWN RAINWATER PIPE
CARP		757	0.50	M	TRIM OPENING FOR ROOF LIGHT
CARP		758	0.33	M.	SKIRTINGS TO BOTH SIDES OF OPENINGS.
CARP		756	1.50	M.SQ	FIX FLOOR BOARDS IN ISOLATED AREAS
CARP		744	0.60	M.SQ	FORM SOLID BALUSTRADE USING PLY DOORS
CARP		724	1.00	M.SQ	TAKE OFF ROOF TILES & STORE FOR RE-USE
CARP		731	0.05	M.SQ	VAPOUR BARRIER
CARP		735	10.00	NO	AIRING CUPD OF 1 SIDE & FRONT BUILT UPO FROM STD UNITS & BBD
CARP		751	1.00	NO	COLLECT UNITS FROM SUPPLIER (ONE JOURNEY)
CARP		749	0.25	NO	CUT OFF ENDS OF JOISTS & SUPPORT TEMPORARILY
CARP		137	0.50	NO	FIT RAINWATER HOPPER
CARP		732	0.25	NO	FIT DOOR STOPS
CARP		740	1.00	NO	FIX NEW EXTERNAL DOOR FRAME
CARP		741	1.00	NO	FIX EXTERNAL DOOR COMPLETE WITH MORTICE LOCK & BOLT
CARP		743	0.12	NO	FIX HOUSE NUMBERS
CARP		750	0.50	NO	FIX JOIST HANGARS INTO EXISTING WALL
CARP		725	0.33	NO	HOLES IN WALL FOR JOISTS
CARP		728	0.50	NO	JOIN NEW PVC GUTTER TO EXISTING GUTTER
CARP		742	2.00	NO	RM HOLE FOR & FIX LETTER BOX & INNER FLAP
CARP		738	0.33	NO	SECURE RAFTERS TO CEILING JOISTS WITH M.S.STRAPS
CARP		730	0.00	NO	SUPPLY ONLY WINDOWS
CARP		736	1.50	NO	TAKE OUT ROOF LIGHT UP TO 1 SQ.M
CARP		739	1.00	NO	TAKE OFF EXTERNAL DOOR & FRAME & PREPARE FOR NEW FRAME
CARP	1FIX	116	0.50	M	BRASKETTING AROUND BEAMS IN PREPARATION FOR PLASTERBOARD
CARP	1FIX	98	0.25	M	CHIPBOARD FLOORING IN OPENINGS
CARP	1FIX	719	1.75	M	FRAMING AROUND RSJ AND DOUBLE PLASTER BOARDING
CARP	1FIX	718	0.20	M	STUD PARTITION 75*50
CARP	1FIX	121	0.16	M	TAKE OUT FLOOR JOIST
CARP	1FIX	124	1.00	M	TAKE OUT WINDOW & PREPARE OPENING FOR NEW
CARP	1FIX	100	0.50	M	WINDOW BOARDS ON BEARERS
CARP	1FIX	97	0.33	M.SQ	CHIPBOARD FLOORING
CARP	1FIX	120	1.50	M.SQ	FIT FLOOR BOARDS IN ISOLATED AREAS

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
CARP	1FIX	105	0.80	M.SQ	MATCHBOARDING IN AREAS EXCEEDING 2 SQ.M
CARP	1FIX	102	0.25	M.SQ	PLASTERBOARDING TO WALLS
CARP	1FIX	103	0.33	M.SQ	PLASTERBOARDING TO CEILINGS
CARP	1FIX	104	0.40	M.SQ	STYROLINER OR SIMILAR BOARDING ON BATTENS
CARP	1FIX	119	0.50	M.SQ	TAKE UP FLOOR BOARDS
CARP	1FIX	113	0.75	M.SQ	TONGUED & GROOVED FLOOR BOARDING 25MM THICK
CARP	1FIX	99	1.00	NO	ASSEMBLE & FIX DOOR LININGS
CARP	1FIX	145	2.00	NO	CAREFULLY TAKE OFF GARAGE DOOR & FRAME
CARP	1FIX	122	0.00	NO	CUT BACK JOIST ENDS & IN
CARP	1FIX	118	1.50	NO	FIT NEW DOOR FRAME INTO EXISING OPENING
CARP	1FIX	191	0.25	NO	FITTED ENDS TO WINDOW BOARDS
CARP	1FIX	722	3.00	NO	PRIME ONLY EXTERNAL JOINERY
CARP	1FIX	146	4.00	NO	REFIX GARAGE DOOR & FRAME IN NEW OPENING
CARP	1FIX	720	1.00	NO	REHANG EXISTING DOOR AND FURNITURE
CARP	1FIX	123	1.00	NO	TAKE OFF INTERNAL DOOR AND MAKE GOOD LINING
CARP	1FIX	717	1.00	NO	TAKE OFF DOOR AND LINING
CARP	2FIX	110	0.16	M	ARCHITRAVES UP TO 75MM WIDE
CARP	2FIX	111	0.20	M	ARCHITRAVES OVER 100 WIDE
CARP	2FIX	112	0.20	M	CURTAIN RAIL
CARP	2FIX	147	0.50	M	FIX HANDRAIL
CARP	2FIX	125	1.00	M	PIPE BOXING TO WATER PIPES
CARP	2FIX	126	1.33	M	PIPE BOXING TO SOIL PIPE
CARP	2FIX	108	0.15	M	SKIRTING UP TO 100 DEEP
CARP	2FIX	109	0.20	M	SKIRTINGS OVER 100 DEEP
CARP	2FIX	721	1.00	M	TAKE OUT WINDOW AND PREPARE OPENING FOR NEW
CARP	2FIX	71	0.15	M.SQ	100MM INSULATION IN ROOF
CARP	2FIX	54	8.00	NO	FIXING TWO LEAF PATIO DOOR & FRAME
CARP	2FIX	107	2.00	NO	INTERNAl DOOR INCLUDING MORTICE LATCH FURNITURE
CARP	2FIX	144	1.50	NO	TAKE OFF MORTICE LATCH MAKE GOOD DOOR & LINING & RENEW
CARP	CARC	76	0.08	M	ALUMINIUM TRIM
CARP	CARC	84	0.30	M	BARGE BOARDS
CARP	CARC	713	0.15	M	CEILING JOISTS
CARP	CARC	115	0.80	M	CONSTRUCT WINDOWS ON SITE FROM FRAMING
CARP	CARC	73	0.33	M	FASCIA BOARDS
CARP	CARC	75	0.10	M	FILLETS & DRIPS
CARP	CARC	149	0.66	M	FIX TIMBER GUTTER
CARP	CARC	4	0.22	M	FIXING WINDOWS
CARP	CARC	68	0.15	M	FIXING MESH FLY SCREEN TO SOFFIT
CARP	CARC	79	0.20	M	FIXING RAFTERS OVER 4M LONG
CARP	CARC	80	0.33	M	FIXING RAFTERS OVER 4 M LONG
CARP	CARC	87	0.40	M	FIXING PVC GUTTER
CARP	CARC	2	0.15	M	GROUND FLOOR JOISTS
CARP	CARC	62	0.12	M	JOISTS TO FLAT ROOF
CARP	CARC	95	0.35	M	MASTIC POINTING
CARP	CARC	74	0.25	M	PLY SOFFIT UP TO 300 OVERHANG
CARP	CARC	83	0.33	M	PURLIN
CARP	CARC	92	0.40	M	PVC PAINWATER PIPE
CARP	CARC	82	0.20	M	RIDGE BOARD
CARP	CARC	715	0.20	M	STUDDING TO DORMER
CARP	CARC	63	0.10	M	TAKE OFF FILLETS AND DRIPS
CARP	CARC	148	0.33	M	TAKE DOWN TIMBER GUTTER

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
CARP	CARC	64	0.10	M	TAPERRED FIRRINGS TO FLAT ROOF
CARP	CARC	81	0.50	M	VALLEY & HIP RAFTERS INC CUTTING RAFTERS BOTH SIDES
CARP	CARC	72	0.40	M.SQ	CHIPBOARD ROOF BOARDING
CARP	CARC	122	0.16	NO	CUT BACK JOIST ENDS
CARP	CARC	88	0.50	NO	ANGLE TO PVC GUTTER
CARP	CARC	89	0.50	NO	ANGLE TO PVC GUTTER
CARP	CARC	93	0.40	NO	BEND ON PVC RWP
CARP	CARC	114	1.50	NO	CORNER POSTS & SUPPORT POSTS BETWEEN WINDOWS
CARP	CARC	60	0.15	NO	CUT BACK RAFTERS
CARP	CARC	86	0.33	NO	CUT OFF BOTTOM OF RWP
CARP	CARC	3	8.00	NO	FIXING GARAGE DOOR AND FRAME
CARP	CARC	6	1.00	NO	FIXING LOUVRES TO TOP OPENING LIGHT OF WINDOW
CARP	CARC	55	0.50	NO	FIXING EXTERNAL DOOR FRAME PREVIOUSLY PLACED BY BRICKLAYERS
CARP	CARC	56	2.50	NO	FIXING EXTERNAL DOOR,LOCK & 2 NO BOLTS
CARP	CARC	57	0.50	NO	FIXING WEATHER BOARD TOP DOOR
CARP	CARC	58	0.00	NO	FIXING ANDERSON TYPE ROOF LIGHT TO FLAT ROOF
CARP	CARC	65	0.15	NO	FIXING ROOF TIES
CARP	CARC	67	0.25	NO	FIXING JOIST HANGARS INTO WALL
CARP	CARC	69	0.15	NO	FIXING TIMBER JOISTS TO ANCHOR BLOCKS
CARP	CARC	77	1.50	NO	FIXING TRUSSED RAFTERS UP TO 5 M SPAN
CARP	CARC	78	2.00	NO	FIXING TRUSSED RAFTERS OVER 5M SPAN
CARP	CARC	150	0.50	NO	JOINT TIMBER GUTTER TO EXISTING
CARP	CARC	91	0.50	NO	OUTLET TOP PVC GUTTER
CARP	CARC	151	1.00	NO	OUTLET TO TIMBER GUTTER AND JOINT TO RWP
CARP	CARC	94	0.25	NO	SHOE TO PVC RWP
CARP	CARC	66	0.15	NO	SPROCKET UP TO 600MM LONG
CARP	CARC	85	0.50	NO	SPROCKET ENDS TO BARGE BOARDS
CARP	CARC	90	0.40	NO	STOP-END TO PVC GUTTER
CARP	CARC	714	1.00	NO	Y BRANCH TO PVC RAINWATER PIPE
CARP	CARC	61	0.25	SQ.M	STRIP OF SINGLE LAP ROOF IN PREP FOR EXTENDING PITCHED ROOF
CARP	DRAN	1	0.10	M	FIX WALL PLATE
CARP	FINS	136	1.00	M	KITCHEN FITTINGS, WORKTOPS
CARP	FINS	127	0.90	NO	KITCHEN FITTINGS, SINGLE BASE UNIT
CARP	FINS	129	1.45	NO	KITCHEN FITTINGS, DOUBLE BASE UNIT
CARP	FINS	130	1.70	NO	KITCHEN FITTINGS, TRIPLE BASE UNIT
CARP	FINS	131	1.50	NO	KITCHEN FITTINGS, DOUBLE SINK BASE UNIT
CARP	FINS	132	1.70	NO	KITCHEN FITTINGS, TRIPLE SINK BASE UNIT
CARP	FINS	133	1.70	NO	KITCHEN FITTINGS, TALL CUPBOARD UNIT
CARP	FINS	134	1.20	NO	KITCHEN FITTINGS, SINGLE WALL UNIT
CARP	FINS	135	2.00	NO	KITCHEN FITTINGS, DOUBLE WALL UNIT
CARP	FMWK	139	1.00	M	FORMWORK TO EDGES UP TO 250 HIGH
CARP	FMWK	140	1.60	M	FORMWORK TO EDGES 250 TO 500 HIGH
CARP	FMWK	142	0.50	M	FORMWORK TO RISERS ON STAIRCASE
CARP	FMWK	143	1.80	M	FORMWORK TO SIDES OF STAIRCASE
CARP	FMWK	141	3.50	M.SQ	FORMWORK TO WALLS (1 USE)
CARP	FMWK	138	2.50	M.SQ	MAKE & FIX FORMWORK TO SOFFITS (1 USE)
CMAT		0	0.00	NO	SUPPLY ONLY WINDOWS
CMAT		1	0.00	NO	SUPPLY ONLY ROOF LIGHT & FLASHINGS
CVAR		1	0.00		
CVAR		2	0.00		
DRN		15	1.00	NO	GRUB UP GULLEY

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
DRN	DRAN	24	0.16	M	LAY 100MM HEPSLEEVE DRAIN
DRN	DRAN	27	0.20	M	LAY 100 PVC DRAIN
DRN	DRAN	16	4.00	M.CO	GRANULER BED TO DRAIN
DRN	DRAN	23	1.00	M.CU	BACKFILL DRAIN TRENCH
DRN	DRAN	20	5.00	M.CU	CONCRETE BED TO DRAIN
DRN	DRAN	21	5.00	M.CU	CONCRETE BEN & HAUNCHING TO DRAIN
DRN	DRAN	22	5.00	M.CU	CONCRETE BED & SURROUND TO DRAIN
DRN	DRAN	1	4.00	M.CU	EXCAVATE FOR MANHOLE OR DRAIN
DRN	DRAN	17	4.00	M.CU	GRANULAR HAUNCHING
DRN	DRAN	18	4.00	M.CU	GRANULAR BED & SURROUND TO 100 DRAIN
DRN	DRAN	19	4.00	M.CU	GRANULAR BED & SURROUND
DRN	DRAN	25	0.30	NO	BENDS TO 100 HEPSLEEVE DRAIN
DRN	DRAN	28	0.30	NO	BENDS TO 100 PVC PIPES
DRN	DRAN	26	0.45	NO	BRANCHES TO 100 HEPSLEEVE DRAIN
DRN	DRAN	29	0.45	NO	BRANCHES TO 100 PVC PIPES
DRN	DRAN	11	3.00	NO	FORM HOLE IN EXISTG. WALL FOR DRAIN INC LINTOL OVER
DRN	DRAN	30	2.00	NO	GULLY AND TRAP AND SET AND SURROUND IN CONCRETE
DRN	EXCV	14	4.00	NO	BREAK INTO MH, BUILD IN DRAIN, JOIN TO CHANNEL & MAKE GOOD
DRN	EXCV	13	2.00	NO	DOUBLE SEAL MANHOLE COVER & FRAME
DRN	EXCV	12	1.00	NO	SINGLE SEAL MANHOLE COVER & FRAME
DRN	MANH	2	5.00	M.CU	CONCRETE BASE TO MANHOLE
DRN	MANH	3	5.00	M.CU	CONC. BASE TO MANHOLE INCLUDING WHEELING UP TO 10M
DRN	MANH	4	6.33	M.CU	CONC.BASE TO MANHOLE INCLUDING WHEELING UP TO 30M
DRN	MANH	5	3.90	M.SQ	BRICKWORK TO MANHOLE
DRN	MANH	10	2.50	NO	BENCHING TO BOTTOM OF MANHOLE
DRN	MANH	8	0.40	NO	BRANCH CHANNEL BEND
DRN	MANH	9	1.00	NO	BUILD IN END OF DRAIN TO EXISTING MANHOLE
DRN	MANH	6	0.40	NO	STRAIGHT MAIN CHANNEL
ELEC		1	0.00	NO	ALL ELECTRICAL WORK
ELEC		2	0.00	NO	ALL ELECTRICAL WORK
GLAZ		4	0.35	M	DOUBLE GLAZING BASED ON PERIMETER OF GLASS
GLAZ		5	0.35	M	DOUBLE GLAZING, BASED ON PERIMITER OF GLASS
GLAZ		6	0.00	NO	SUPPLY ONLY SINGLE GLAZING
GLAZ	DOUB	3	0.00	NO	SUPPLY ONLY DOUBLE GLAZING
GLAZ	SING	1	0.25	M	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS
LAB		73	0.00		
LAB		65	0.20	M	TAKE DOWN SHELVING
LAB		69	6.00	M.CU	CONCRETE 300 THICK & WHEEL UP TO 30M
LAB		80	3.00	M.CU	EXCAVATE PIT BY HAND
LAB		67	0.50	M.SQ	HACK OFF WALL TILES
LAB		70	0.60	M.SQ	HACK UP BRICK PAVING
LAB		68	1.85	M.SQ	RAKE OUT JOINT & POINT STACKS
LAB		66	0.25	M.SQ	TAKE DOWN WALL BOARDING
LAB		72	1.00	NO	DISCONNECT & REMOVE GAS COOKER
LAB		74	3.00	NO	EXC PIT
LAB		83	1.00	NO	REMOVE DOOR AND FRAME
LAB		84	1.00	NO	REMOVE DOOR AND FRAME
LAB		64	1.00	NO	TAKE OUT GAS PIPING
LAB		71	3.00	NO	TAKE OUT KITCHEN UNITS & FITTINGS
LAB		82	4.00	NO.	GRUB UP TREE ROOTS, 600 GIRTH.
LAB	BRKT	57	1.50	M	INSERT LINTOL IN CAVITY WALL OR ONE BRICK WALL

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
LAB	BRKT	60	1.00	M	INSERT LINTOL IN HALF BRICK OR BLOCK WALL & MAKE GOOD OVER
LAB	BRKT	56	1.00	M	QUOIN UP JAMBS OF CAVITY WALL OR ONE BRICK WALL
LAB	BRKT	59	0.50	M	QUOIN UP JAMBS OF HALF BRICK OR BLOCK WALL
LAB	BRKT	54	1.50	M	SUPPORT WALLING OVER OPENING
LAB	BRKT	55	1.50	M.SQ	TAKE DOWN CAVITY WALL OR 1 BRICK WALL TO FORM OPENING
LAB	BRKT	58	0.75	M.SQ	TAKE DOWN HALF BRICK OR BLOCK WALL TO FORM OPENING
LAB	BRKT	63	1.50	NO	CUT OUT FOR AND INSERT PADSTONES INCLUDING MAKING GOOD
LAB	CARC	42	0.60	M.SQ	TAKE OFF FLAT ROOF OF TIMBER CONSTRUCTION
LAB	CONC	18	5.33	M.CU	CONCRETE IN FOUNDATIONS INCLUDING WHEELING UP TO 30M
LAB	CONC	16	5.33	M.CU	OVERSITE CONCRETE 150 THICK
LAB	CONC	21	0.60	M.SQ	ARDIT SCREED
LAB	CONC	17	4.00	M.SQ	CONCRETE IN FOUNDATIONS INCLUDING WHEELING UP TO 10M.
LAB	DEMO	61	0.50	M.SQ	TAKE DOWN EXTERNAL HALF BRICK WALL
LAB	DEMO	62	1.00	M.SQ	TAKE DOWN EXTERNAL ONE BRICK WALL
LAB	DISP	15	1.00	M.CU	BACKFILL EXCAVATION
LAB	DISP	7	1.20	M.CU	DEPOSIT EXCAVATED MATERIAL ON SITE
LAB	DISP	9	1.33	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP
LAB	DISP	11	2.66	M.CU	WHEEL MATERIAL UP TO 40 M. AND DEPOSIT IN SKIP
LAB	DISP	8	0.50	M.SQ	REMOVE SLABS FROM SITE
LAB	DPM	20	0.06	M.SQ	DAMP PROOF MEMBRANE
LAB	EXCV	3	4.00	M.CU	EXCAVATE OVER SITE AVE.150 DEEP
LAB	EXCV	6	4.00	M.CU	EXCAVATE TRENCH
LAB	EXCV	1	0.66	M.SQ	BREAK UP ASPHALT AND BASE 50MM THICK
LAB	EXCV	2	1.33	M.SQ	BREAK UP ASPHALT EXCAVATE BASE 150MM THICK
LAB	EXCV	12	1.20	M.SQ	BREAK UP UNREINFORCED CONCRETE 150 THICK
LAB	EXCV	13	2.00	M.SQ	BREAK UP CONCRETE, LIGHTLY REINFORCED, 150 THICK
LAB	EXCV	14	4.00	M.SQ	BREAK UP CONCRETE, HEAVILY REINFORCED, 225 THICK
LAB	EXCV	4	0.60	M.SQ	TAKE UP PAVING FLAGS
LAB	HCOR	23	2.70	M.CU	CONSOLIDATING HARDCORE WITH VIBRATING ROLLER
LAB	HCOR	24	2.00	M.CU	HARDCORE FILLING UNDER FLOORS
LAB	HCOR	25	0.30	M.SQ	BLINDING TO HARDCORE
LAB	MISC	22	6.00	M.CU	CONCRETE CAVITY FILL
LAB	PAVE	5	1.50	M.SQ	LAY PAVING FLAGS 900 X 600
LAB	PREP	49	0.60	M.SQ	CLEAN BRICKS & STORE FOR RE-USE - HALF BRICK WALL
LAB	PREP	50	1.20	M.SQ	CLEAN BRICKS & STORE FOR RE-USE - ONE BRICK WALL
LAB	PREP	48	0.60	M.SQ	HACVK OFF LATH AND PLASTER CEILING
LAB	PREP	43	2.50	M.SQ	MAKE GOOD TARMAC PAVING WITHE COLD ROLLED ASPHALT
LAB	PREP	44	0.40	M.SQ	STRIP OFF PLASTER FROM WALLS - SOFT
LAB	PREP	45	0.70	M.SQ	STRIP OFF PLASTER FROM WALLS - HARD
LAB	PREP	46	0.50	M.SQ	STRIP OFF RENDER & DASH FROM WALLS - SOFT
LAB	PREP	47	0.70	M.SQ	STRIP OFF RENDER & DASH FROM WALLS - HARD
LAB	PREP	51	0.40	M.SQ	TAKE DOWN STUD PARTITION
LAB	PREP	53	2.00	NO	GENERAL PROTECTION PRIOR TO BREAKTHROUGH
LAB	PREP	52	1.00	NO	TAKE OUT FIREPLACE, SURROUND & HEARTH
LAB	REIN	19	0.10	M.SQ	LIGHT MESH REINFORCEMENT
LAB	SUBC	81	0.33	M.CU	EXCAVATE PIT MECHANICALLY
MATS		6	0.00	NO	SUPPLY ONLY LINTOLS
PLAS		2	0.00		R AND S FILLING OPENINGS.
PLAS		1	0.00	NO	PLASTERING & PLASTERBOARD & SKIM
PLUM		2	0.00	NO	ALL PLUMBING WORK
PREL		0	0.00	NO.	PRELIMINARIES.

TRAD	SUBT	NO	OUTPUT	UNIT	DESCRIPTION
ROOF		20	0.65	M	REPOINT RIDGE OR HIP TILES
ROOF		21	0.25	NO	REPLACE DAMAGED SLATES IN AREAS UP TO 1 M.SQ
ROOF		19	0.10	NO	TAKE OFF SLATES TO FORM OPENING UP TO 2M.SQ
ROOF	LEAD	17	0.00	1	FLASHINGS TO DORMER
ROOF	LEAD	10	0.50	M	COVER FLASHING 150 WIDE
ROOF	LEAD	12	0.80	M	FLASHING 150-300 WIDE
ROOF	LEAD	9	0.05	M	REMOVE FLASHING 150 WIDE
ROOF	LEAD	11	0.07	M	REMOVE FLASHING 150-300 WIDE
ROOF	LEAD	14	0.10	M	REMOVE STEPPED FLASHING 150 GIRTH
ROOF	LEAD	18	1.00	M.SQ	REFIX TILES ON FELT ON BATTENS AROUND DORMER
ROOF	REPS	3	0.85	M	TAKE OFF & REBED RIDGE OR HIP TILES
ROOF	REPS	4	0.25	NO	REPLACE DAMAGED SLATES- SINGLE SLATES
ROOF	REPS	5	1.33	NO	REPLACE DAMAGED SLATES IN AREAS UP TO 1 SQ.M
ROOF	REPS	6	2.00	NO	REPLACE DAMAGED SLATES IN AREAS 1 - 2 SQ.M
ROOF	ROOF	16	0.00	1	ALL ROOF WORK
ROOF	ROOF	8	0.00	M	REPOINT RIDGE OR HIP TILES
ROOF	ROOF	2	0.30	M	VERVES TO SINGLE LAP TILES
ROOF	ROOF	7	0.45	M.SQ	DOUBLE LAP TILES ON FELT ON BATTENS
ROOF	ROOF	1	0.30	M.SQ	SINGLE LAP TILES ON FELT ON BATTENS
STYU		0	0.00		
SUBC		2	0.00	NO	ALL ELECTRICAL WORK
SUBC		3	0.00	NO	ALL PLASTERING WORK
SUBC		4	0.00	NO	ALL PAINTING WORK
SUBC		0	0.00	NO	CHEMICAL INJECTED DPC
SUBC		1	0.00	NO	PLUMBING & HEATING
TILE		0	4.00	M.SQ	TILE SPLASH BACK & SILLS
ZZZZ		9999	0.00		

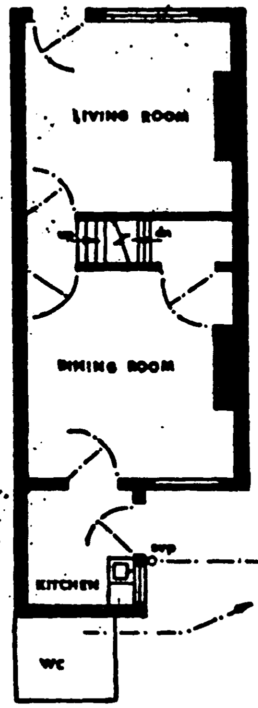
REF	TRAD NO	SECT	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST
059	ROOF016	CAR1	0.10	26.00	NO	TAKE OFF SLATES TO FORM OPENINGS UP TO 2 M.SQ	9.67
060	CARP160	CAR1	14.00	1.00	NO	FIX ROOFLIGHT UP TO 2 M.SQ INC FLASHING & M.G.SLATES TO EDGE	52.08
0601	CARP180	CAR1	1.60	5.00	M	FIX VELUX ROOF LIGHT & FLASHINGS (BASED ON PER. OF LIGHT)	29.76
061	CARP161	CAR1	0.33	12.00	NO	SECURE RAFTERS TO CLG JSTS WITH M.S.STRAPS	14.73
062	CARP162	CAR1	1.00	1.00	NO	TAKE OT EXTERNAL DOOR & FRAME AND PREPARE FOR NEW FRAME	3.72
063	CARP163	CAR1	1.00	1.00	NO	FIX NEW EXTERNAL DOOR FRAME	3.72
085	CARP092	CARX	0.16	5.00	M	PVC RAINWATER PIPE	2.97
086	LAB 095	LABX	6.00	0.50		CONCRETE 100 THICK & WHEEL UP TO 30M	9.48
087	LAB 096	LABX	0.60	6.20	M.SQ	KACK UP BRICK PAVING	11.75
093	BLR 176	BLRX	1.85	3.80	M.SQ	RAKE OUT JOINT & POINT STACK	26.15
						PAGE TOTALS	269.19
32	CARP002	CAR1	0.15	3.67	M	GROUND FLOOR JOISTS	2.04
33	CARP092	CARX	0.40	5.00	M	PVC RAINWATER PIPE	7.44
968	CARP165	PREP	0.14	3.50	M	TAKE OF HANDRAIL	1.54
prep	LAB 009	PREP	1.33	0.75	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	3.15
						TOTALS	1272.49

APPENDIX 4.4.

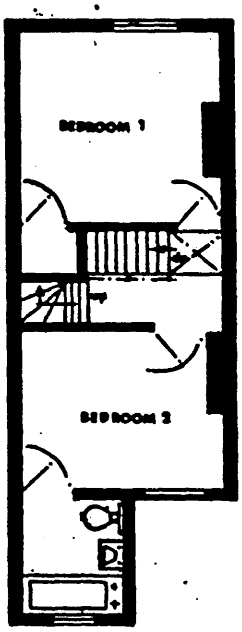
FINAL CONTRACT DOCUMENTS AND REPORTS FOR 'MEAT'.

Providence Road

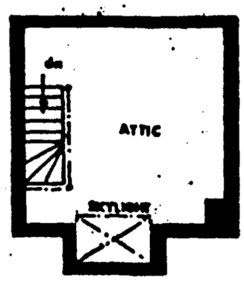
Proposed Alterations



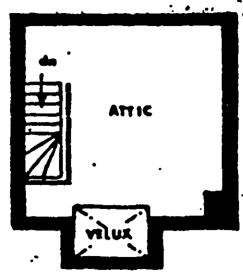
Present Ground Floor



Present First Floor



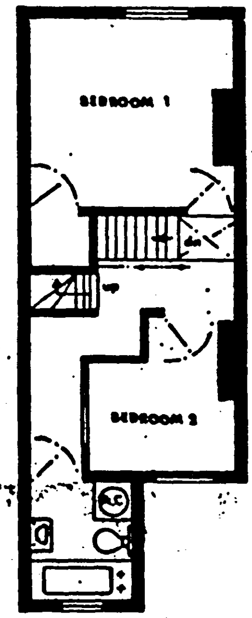
Present Attic



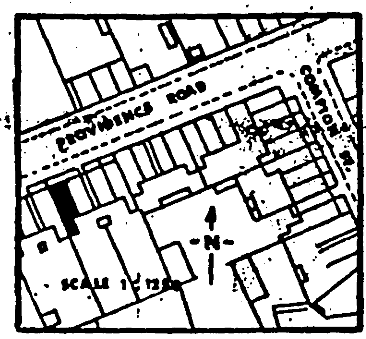
Proposed Attic

BEDROOM NOTES:

Bedroom 2 to be split with 75 mm x 50 mm stud partition.
Provide and fix window in stud partition to give borrowed light into passage.
Provide double joists beneath stud partition walls.
Bathroom window to have concrete lintel and DPC.
Lintel to have min 6" bearing to either side.
Bathroom window to be frosted and min. 1050 mm above floor.
Form airing cupboard with HW cylinder.
Bath to have 38 mm waste.
Sink to have 32 mm waste.
Deep seal traps to all appliances to BS 5572.
SVP to be led into existing drains and to terminate 900 mm above or 3000 mm from nearest opening light.
100 mm plastic SVP.
Discharge of waste 200 mm min below WC.
New drains to have flexible joints with fall 1:40 and to satisfy DBS.
New inspection chamber to be constructed of 9" engineering bricks with concrete benching.



Proposed First Floor



SCALE 8FT=1INCH

Fig A4.1 Drawing And Spec ...

PLAN No. 297

Figure A4.1. Drawing and Specification For 'PROVID' Estimate.

SPECIFICATION

· Providence Road, SHEFFIELD

SERVICES

1. Electricity, gas and water services supplies appear to meet present day standards although formal confirmation to this effect is required from the appropriate Statutory Authorities.

IMPROVEMENTS

2. Install an efficient horizontal damp proof course (30 year guarantee required), in all internal and external walls.

3. Hack off all plaster to a height of one metre above damp proof course and reinstate.

4. Replace disturbed skirting boards to ground floor rooms with new skirting boards of 5" moulded style.

Plumbing

5. O&P ← Remove existing gas fire and wooden surround in rear living room, provide and install 'Baxi Bermuda' or similar gas fired back boiler together with Copex liner, starter plate, clamp plates, terminal and gas fire.

6. O&P ← Remove existing gas fire and surround in front room, provide and install Copex liner, starter plate, clamp plates, terminal and 'Glowworm Capricorn' gas fire or similar.

7. O&P { Remove existing sink unit and sundry appliances from kitchen. + gas cooker, washer & freezer.

8. Provide and install new 'Boulton & Paul' single drainer stainless steel sink unit, 1000mm x 600mm. Provide and install one pair taps, plug and chain and all supply and waste pipes.
B & P. sink unit base to be collected by O & P.

• Install Group 1 'Pampas' coloured bathroom suite comprising perspex bath, wash hand basin and water closet together with all taps, supply pipes and fixings and PVC soil and vent pipe. (Re-use S & VP).

   (a) PVC pipe to terminate at least 900 mm nearest window opening.

   (b) Any two connections to soil and vent pipe to be minimum 200 mm apart.

John Burke to take out ext'g. bathroom suite.

~~(c) Manhole to be situated at base of soil and vent pipe~~.

~~(d) Drains to have a minimum fall of 1:40~~.

10. Install hot water cylinder, jacket and insulation, all plumbing service pipes to bath, wash hand basin and kitchen.

11. Provide central heating throughout the property, one single banked radiator to be strategically located in each room except the kitchen.

12. Install 25 gallon cold water tank in roof space with all plumbings and fixings.

13. ~~Form new water service from boundary and~~ provide new stop tap in cellar.

Kitchen

14. Remove existing kitchen window, raise sill height, install new wood framed picture window with top hung opening light.
(3'9" x 2'5" 1 No.).

15. Provide and install three course white ceramic tiled splash back to sink unit.
(Crystal, 4" square or similar).

Bathroom

6. Remove existing rear bedroom door and form new door openings (as per drawing), to serve passage and bedroom.

7. Construct stoothing walls with window to provide borrowed light in rear bedroom to form passage to bathroom (as per plan).

8. Provide and install new internal faced doors to bathroom and bedroom, all furniture to be supplied and fitted, including door stops where necessary.
(2'6" x 6'6" 2 No.).

9. Supply and install new wood framed casement window translucent glazed to be a minimum of 105 cm above floor level and to have Monks concrete lintel or similar.
(4'4" x 2'4").

20 Provide and form airing cupboard in bathroom to house hot water cylinder.

21 Provide three course "veined" ceramic tiled splash back to bath and wash hand basin to match coloured bathroom suite. (Crystal type, 4" square or similar).

Attic

22. Remove existing roof light, provide and fix 'Velux' window complete with flashings and soakers. (1200 mm x 1200 mm)

Roof Space

23. Provide and fix galvanised mild steel straps to feet of every second rafter secured to ceiling joists.

REPAIRS

Internal,

Kitchen

24. Provide and install new external door and frame, all furniture to be supplied and fitted. (6'6" x 2'6" x 1½" 1 No.).

25. Remove excess existing gas piping, provide and install gas cooker point.

26. Remove shelves and cupboards and make good prior to decoration.

27. Hack off existing plaster and replaster as necessary. (Approximately 16 square yards). cl ok!

28. Plasterboard and skim ceiling ~~as necessary~~. (Approximately 5 square yards).

29. Provide and install new internal faced door to rear living room, all furniture to be supplied and fitted. (6'5" x 2'6" x 1¼ rebate 1 No.)

30. Take up existing solid floor, fill void with consolidated rubble, blind with sand or similar fine material, provide damp proof membrane to be lapped into damp proof course, concrete and screed to existing floor level. (Approximately 5 square yards).

Rear Living Room

31. Provide and install new internal faced doors to cellarhead and stair base, all furniture to be supplied and fitted. (6'6" x 2'6" x 1¼ rebate - 2 No.)

32. Hack off and replaster walls as necessary. (Approximately 8 square yards).

33. Remove existing top hung louvre window, provide and install new picture window with top hung opening light.
(6'6" x 3'6" 1 No.).

34. Take out boxing around water pipes to rear wall and adjacent to chimney and remove hot water cylinder.

35. Take up floorboards under window to ascertain condition of joist ends. (3 sy)

36. LANDING. Remove pin rail, replaster and make good prior to decoration.
(Approximately 1 square yard).

37. Provide and install single hand rail.
(10 linear feet approximately).

Front Room

38. Provide and install new internal faced door to stair base, all furniture to be supplied and fitted.
(6'5" x 2'5" x 1¼ rebate - 1 No.).

39. Cut back those floorboards affected by wet rot and replace with suitably treated timbers adjacent to front entrance door.

40. Provide and install new external door, all furniture to be provided and fitted. + new door frame architrave and threshold + letter box & flap & base nr.
(6'8" x 2'8" x 1½ rebate - 1 No.).

41. Remove all wall boarding and cart away. 14sy

42. Remove existing sash windows, provide and install new picture windows with top hung opening light.
(Approximately 6'0" x 5'0").

Front Bedroom

43. Take out existing window, install wood framed picture window with top hung opening light.
(Approximately 6'0" x 3'6").

44. Hack off and replace existing wall plaster to front wall and clothes closet as necessary. (Approximately 4 square yards).

45. Take out fireplace and plasterboard over, skim and fit matching skirting board.

46. Plasterboard and skim ceiling as necessary prior to redecoration. (Approximately 11'6" x 11'10").

47. Take out existing pin rail and hangers to clothes closet and make good prior to decoration.

48. Provide and install new internal faced doors to stair head and walk-in clothes closet, all furniture to be supplied and fitted. (6'6" x 2'6" x 1¼" rebate - 2 No.).

Rear Bedroom

49. Replaster walls as necessary (5 square yards).

50. Remove existing sash window, provide and install new wood framed picture window with top hung opening light. (6'0" x 3'6" approximately).

51. Take out fireplace and plasterboard over, skim and fit matching skirting board.

Ceiling needs patching [illegible]
[illegible]
[illegible]

Bathroom

52. Take down, plasterboard and skim ceiling as necessary prior to redecoration. (Approximately 6 square yards).

Ceiling only needs patching [illegible]

53. Hack off wall plaster and replaster. (6 square yards).

54. Remove existing wall tiles.

55. ATTIC Provide and install single hand rail. (6 linear feet approximately).

56. Box-in rail and posts in attic. with plywood doors & hwd. capping, & skirtings.

Attic

57. Hack off existing wall and ceiling plaster and replace as necessary, including stairs to attic. (Approximately 35 square yards).

Ceiling needs skimming only [illegible]

58. Box-in both purlins with plasterboard. & skim

Cellar

59. Remove shelves from cellarhead and replace prior to decoration.

60. Provide new grate for cellar ventilation.

61. Hack down and replaster walls and ceiling to cellarhead. (Approximately 5 square yards).

62. Cart all rubbish and all removed under-drawing away.

63. Take out first joist and replace with suitably treated timber, ensuring joist ends are wrapped in polythene. including taking up exl'g. floor boards, as necessary, & replacing with new.

4. Check all joist ends and cut back those affected by wet rot, resupporting the joists as necessary. (6 No).

EXTERNAL

5. Replace eaves ogee gutters to offshot and rear roofs as necessary. (~~14~~ 20 linear feet approximately).

6. Clean and overhaul front ogee gutter.

7. Repoint verge of roof to off-shot. (83linear feet approximately).

8. Take down cast iron downpipes to off-shot and replace with suitable PVC. (~~20~~ 16 foot length approximately).

. Rake out defective pointing as necessary and replace with suitable mortar to rear elevation and side and rear elevation of off-shot. (20 square yards).

. ~~Take down and cap off rear single storey off-shot chimney below slates and make good 100 feet as necessary.~~

. Rake out defective pointing and replace with suitable mortar chimney stack. (Approximately 2 square yards).

. ~~Attend to flashings and soakers as necessary on front and rear chimney~~ stacks.

Repoint chimney stack to offshot.

73. Reseal valley between off-shot and rear pitch of roof.

74. Repoint ridge tiles (6 No.).

75. Attend to slipped slates and replace broken slates on front and rear of roof and off-shot roof as necessary. (10 No.)

76. Insert 9" x 2½" air brick in rear elevation to assist with sub-floor ventilation.

77. J. B. Remove chimney pots, provide ~~mushroom cap or~~ gas flue terminals as necessary. (2 No)

78. Attend to and re-render jump gable as necessary. (10 square yards approximately).

79. Rake out defective pointing as necessary and replace with suitable mortar to front elevation. (8 square yards).

80. Re-lay the rear yard with suitable material and bring to an even surface with suitable fall. (Approximately 12 square yards).
Hack up & relay 3"th. conc. slab.

81. Remove bricks from front forecourt and with suitable material bring to an even surface. (Approximately 6 square yards).
Lay 3"th. conc. slab.

82. Take down and rebuild retaining garden wall. (Approximately 4 linear yards x 2'6" height).

83. Tidy and leave site in clean condition.

SERVICES

84. O & P — Remove all existing electric wiring and casing and rewire property to Parker Morris standard.

85. O & P Remove all excess unwanted water piping throughout the property.

DECORATION

86. All internal walls and where necessary ceiling to be prepared and papered with woodchip paper and magnolia emulsion painted. (Ceilings to be white).

87. Cellarhead, stairs and cellar to be painted with lime wash.

88. All internal woodwork to be prepared and painted with three coats of good quality white paint including one coat of gloss.

ESTIMATE FOR PROVID 1

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
5	LAB	12	PREP	1.20	4.00	M.SQ	BREAK UP UNREINFORCED CONCRETE 150 THICK	15.93	0.00	0.00	0.00	15.93
6	LAB	16	PREP	5.33	0.60	M.CU	OVERSITE CONCRETE 150 THICK	10.61	17.40	0.00	0.00	28.01
7	LAB	20	PREP	0.06	4.00	M.SQ	DAMP PROOF MEMBRANE	0.79	0.88	0.00	0.00	1.67
9	LAB	21	PREP	0.60	4.00	M.SQ	ARDIT SCREED	7.96	2.00	0.00	0.00	9.96
10	LAB	44	PREP	0.40	34.00	M.SQ	STRIP OFF PLASTER FROM WALLS - SOFT	49.36	0.00	0.00	0.00	49.36
11	LAB	52	PREP	2.00	2.00	NO	TAKE OUT FIREPLACE, SURROUND & HEARTH	13.28	0.00	0.00	0.00	13.28
12	LAB	71	PREP	3.00	1.00	NO	TAKE OUT KITCHEN UNITS & FITTI NGS	9.96	0.00	0.00	0.00	9.96
14	LAB	72	PREP	1.00	1.00	NO	DISCONNECT & REMOVE GAS COOKER	3.32	0.00	0.00	0.00	3.32
15	LAB	9	PREP	1.33	1.33	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	5.87	0.00	16.45	0.00	22.32
16	SUBC	0	SUBC	0.00	1.00	NO	CHEMICAL INJECTED DPC	0.00	0.00	0.00	238.00	238.00
20	CARP	109	CAR2	0.20	33.00	M	SKIRTINGS OVER 100 DEEP	25.80	32.34	0.00	0.00	58.14
22	SUBC	1	SUBS	0.00	1.00	NO	PLUMBING & HEATING	0.00	0.00	0.00	1890.00	1890.00
25	CARP	125	CAR2	1.00	5.00	M	PIPE BOXING TO WATER PIPES	19.55	12.25	0.00	0.00	31.80
30	CARP	124	CAR1	0.33	36.00	M	TAKE OUT WINDOW & PREPARE OPEN ING FOR NEW	46.45	0.00	0.00	0.00	46.45
31	BLR	60	CAR1	1.00	2.00	M	TAKE OUT STONE OR CONCRETE SIL L	7.82	0.00	0.00	0.00	7.82
32	BLR	91	CAR1	4.00	0.60	M.SQ	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	9.38	9.60	0.00	0.00	18.98
33	BLR	71	CAR1	1.00	2.00	M	REFIX CONCRETE OR STONE CILL	7.82	0.60	0.00	0.00	8.42
							PAGE TOTALS	233.94	75.07	16.45	2128.00	2453.47

Figure A4.2. ESTIMATE PRODUCED FOR CONTRACTOR.

ESTIMATE FOR PROVID

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
34	CARP	752	CAR1	0.55	24.77	M	FILLING RECESSES TO SQUARE OFF JAMBS	53.26	12.38	0.00	0.00	65.6[illegible]
35	BLR	41	CAR1	1.00	1.12	M	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING	4.37	0.84	0.00	0.00	5.21
36	GLAZ	6	CMAT	0.00	1.00	NO	SUPPLY ONLY SINGLE GLAZING	0.00	78.48	0.00	0.00	78.48
40	CARP	4	CAR1	0.22	31.00	M	FIXING WINDOWS	26.66	3.10	0.00	0.00	29.76
45	CMAT	0		0.00	1.00	NO	SUPPLY ONLY WINDOWS	0.00	206.74	0.00	0.00	206.74
55	CARP	95	CAR1	0.20	32.17	M	MASTIC POINTING	25.15	9.32	0.00	0.00	34.48
60	GLAZ	1	CAR1	0.25	39.00	M	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS	38.12	0.00	0.00	0.00	38.12
65	CARP	100	CAR1	0.50	6.42	M	WINDOW BOARDS ON BEARERS	12.55	14.44	0.00	0.00	26.99
70	CARP	123	CAR1	1.00	8.00	NO	TAKE OFF INTERNAL DOOR AND MAK E GOOD LINING	31.28	0.00	0.00	0.00	31.28
75	LAB	9	CAR1	1.33	1.00	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	5.20	0.00	12.36	0.00	17.56
80	CARP	107	CAR1	2.00	8.00	NO	INTERNAL DOOR INCLUDING MORTIC E LATCH FURNITURE	62.56	66.40	0.00	0.00	128.96
81	CARP	111	CAR2	0.20	5.00	M	ARCHITRAVES OVER 100 WIDE	3.91	1.60	0.00	0.00	5.51
85	CARP	732	CAR2	0.25	2.00	NO	FIT DOOR STOPS	1.95	0.50	0.00	0.00	2.45
86	CARP	751	CAR2	1.00	1.00	NO	COLLECT UNITS FROM SUPPLIER (O NE JOURNEY)	3.91	0.00	0.00	0.00	3.91
90	BLR	90	PREP	1.50	1.68	M.SQ	HALF BRICK WALL IN FILLING OPE NINGS UP TO 1 SQ.M	9.85	6.30	0.00	0.00	16.15
95	CARP	733	CAR1	1.00	6.00	M	MAKE GOOD FLOOR OR CEILING WHE RE PARTITION REMOVED	23.46	3.00	0.00	0.00	26.46
101	LAB	44	PREP	0.40	49.56	M.SQ	STRIP OFF PLASTER FROM WALLS - SOFT	65.81	0.00	0.00	0.00	65.81
							PAGE TOTALS	368.08	403.11	12.36	0.00	783.57

ESTIMATE FOR PROVID 3

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
102	LAB	11	PREP	2.66	1.20	M.CU	WHEEL MATERIAL UP TO 40 M. AND DEPOSIT IN SKIP	10.59	0.00	29.68	0.00	40.28
103	CARP	109	CAR2	0.20	1.80	M	SKIRTINGS OVER 100 DEEP	1.40	1.76	0.00	0.00	3.17
104	LAB	51	PREP	0.40	2.02	M.SQ	TAKE DOWN STUD PARTITION	2.68	0.00	0.00	0.00	2.68
105	CARP	734	CAR1	0.20	59.00	M	STUD PARTITION	46.13	46.02	0.00	0.00	92.15
106	CARP	115	CAR1	0.80	3.67	M	CONSTRUCT WINDOWS ON SITE FROM FRAMING	11.47	2.27	0.00	0.00	13.75
107	GLAZ	1	CAR2	0.25	3.50	M	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS	3.42	0.00	0.00	0.00	3.42
108	LAB	52	PREP	2.00	4.00	NO	TAKE OUT FIREPLACE, SURROUND & HEARTH	26.56	0.00	0.00	0.00	26.56
110	CARP	735	CAR2	10.00	1.00	NO	AIRING CUPD OF 1 SIDE & FRONT BUILT UPO FROM STD UNITS & BBD	39.10	47.50	0.00	0.00	86.60
115	CARP	736	CAR1	1.50	1.00	NO	TAKE OUT ROOF LIGHT UP TO 1 SQ .M	5.86	0.00	0.00	0.00	5.86
120	ROOF	19	CAR1	0.10	26.00	NO	TAKE OFF SLATES TO FORM OPENIN G UP TO 2M.SQ	10.16	0.00	0.00	0.00	10.16
122	CMAT	1	CMAT	0.00	1.00	NO	SUPPLY ONLY ROOF LIGHT & FLASH INGS	0.00	142.70	0.00	0.00	142.70
123	CARP	757	CAR1	0.50	5.00	M	TRIM OPENING FOR ROOF LIGHT	8.30	4.55	0.00	0.00	12.85
125	CARP	737	CAR1	14.00	5.00	M	FIX VELUX ROOFLIGHT & FLASHING (BASED ON PERIMITER OF ROOFL'T	273.70	0.00	0.00	0.00	273.70
130	CARP	738	CAR1	0.33	12.00	NO	SECURE RAFTERS TO CEILING JOIS TS WITH M.S.STRAPS	15.48	9.00	0.00	0.00	24.48
135	CARP	739	CAR1	1.00	1.00	NO	TAKE OFF EXTERNAL DOOR & FRAME & PREPARE FOR NEW FRAME	3.91	0.50	0.00	0.00	4.41
140	CARP	740	CAR1	1.00	1.00	NO	FIX NEW EXTERNAL DOOR FRAME	3.91	29.41	0.00	0.00	33.32
145	CARP	741	CAR1	1.00	1.00	NO	FIX EXTERNAL DOOR COMPLETE WIT H MORTICE LOCK & BOLT	3.91	29.41	0.00	0.00	33.32
							PAGE TOTALS	466.63	313.12	29.68	0.00	809.44

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
150	LAB	64	PREP	1.00	1.00	NO	TAKE OUT GAS PIPING	3.32	0.00	0.00	0.00	3.32
155	LAB	65	PREP	0.20	5.50	M	TAKE DOWN SHELVING	3.65	0.00	0.00	0.00	3.65
160	CARP	742	CAR1	2.00	1.00	NO	RM HOLE FOR & FIX LETTER BOX & INNER FLAP	6.64	5.50	0.00	0.00	12.14
170	CARP	743	CAR1	0.12	4.00	NO	FIX HOUSE NUMBERS	1.59	2.00	0.00	0.00	3.59
171	CARP	753	PREP	0.14	3.50	M	TAKE OFF HANDRAIL	1.62	0.00	0.00	0.00	1.62
172	CARP	755	CAR2	0.50	3.20	M	FIX HANDRAIL	6.25	14.27	0.00	0.00	20.52
173	CARP	756	CAR2	1.50	5.00	M.SQ	FIX FLOOR BOARDS IN ISOLATED A REAS	29.32	25.00	0.00	0.00	54.32
175	CARP	119	CAR2	0.50	5.00	M.SQ	TAKE UP FLOOR BOARDS	23.27	0.00	0.00	0.00	23.27
180	CARP	109	CAR2	0.20	5.80	M	SKIRTINGS OVER 100 DEEP	10.79	5.68	0.00	0.00	16.48
185	CARP	56	CAR2	2.50	1.00	NO	FIXING EXTERNAL DOOR,LOCK & 2 NO BOLTS	23.27	29.41	0.00	0.00	52.68
190	CARP	57	CAR2	0.50	1.00	NO	FIXING WEATHER BOARD TOP DOOR	4.65	1.25	0.00	0.00	5.90
195	LAB	66	PREP	0.25	11.75	M.SQ	TAKE DOWN WALL BOARDING	10.66	0.00	0.00	0.00	10.66
200	LAB	67	PREP	0.50	2.75	M.SQ	HACK OFF WALL TILES	4.99	0.00	0.00	0.00	4.99
205	CARP	744	CAR2	0.60	5.00	M.SQ	FORM SOLID BALUSTRADE USING PL Y DOORS	10.89	10.00	0.00	0.00	20.89
210	CARP	745	CAR2	0.50	3.00	M	CAPPING TO TIMBER PANEL	5.44	5.10	0.00	0.00	10.54
211	CARP	109	CAR2	0.20	8.26	M	SKIRTINGS OVER 100 DEEP	6.45	8.09	0.00	0.00	14.55
215	CARP	746	CAR2	0.75	1.00	M	225 WIDE SHELVING INCLUDING BE ARERS & BRACKETS	2.93	0.55	0.00	0.00	3.48
							PAGE TOTALS	155.79	106.86	0.00	0.00	262.65

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
216	TILE	0	TILE	4.00	2.30	M.SQ	TILE SPLASH BACK & SILLS	35.97	18.99	0.00	0.00	54.97
220	CARP	747	CAR1	0.25	4.00	M	TAKE OUT FLOOR JOISTS	3.91	0.00	0.00	0.00	3.91
225	CARP	748	CAR1	0.50	3.00	M	100 X 50 BEARER SECURED TO WAL L AS SUPPORT FOR JOIST	5.86	2.70	0.00	0.00	8.56
230	CARP	749	CAR1	0.25	6.00	NO	CUT OFF ENDS OF JOISTS & SUPPO RT TEMPORARILY	5.86	1.80	0.00	0.00	7.66
235	CARP	750	CAR1	0.50	6.00	NO	FIX JOIST HANGARS INTO EXISTIN G WALL	11.73	6.90	0.00	0.00	18.63
236	CARP	2	CAR1	0.15	3.67	M	GROUND FLOOR JOISTS	2.15	6.71	0.00	0.00	8.86
240	CARP	148	CARX	0.33	6.42	M	TAKE DOWN TIMBER GUTTER	8.28	0.00	0.00	0.00	8.28
245	CARP	149	CARX	0.66	6.42	M	FIX TIMBER GUTTER	16.56	18.87	0.00	0.00	35.44
250	CARP	151	CARX	1.00	1.00	NO	OUTLET TO TIMBER GUTTER AND JO INT TO RWP	3.91	1.00	0.00	0.00	4.91
251	CARP	92	CARX	0.40	5.00	M	PVC RAINWATER PIPE	7.82	6.25	0.00	0.00	14.07
255	CARP	94	CARX	0.25	1.00	NO	SHOE TO PVC RWP	0.97	0.90	0.00	0.00	1.87
260	BLR	53	BLRX	1.25	23.30	M.SQ	RAKE OUT JOINTS & POINT BRICKW ORK - SOFT MORTAR	113.87	2.33	0.00	0.00	116.20
265	ROOF	20	BLRX	0.65	5.00	M	REPOINT RIDGE OR HIP TILES	12.70	1.00	0.00	0.00	13.70
270	ROOF	21	BLRX	0.25	10.00	NO	REPLACE DAMAGED SLATES IN AREA S UP TO 1 M.SQ	9.77	10.00	0.00	0.00	19.77
275	LAB	1	LABX	0.66	10.00	M.SQ	BREAK UP ASPHALT AND BASE 50MM THICK	23.95	0.00	0.00	0.00	23.95
285	BLR	37	BLRX	2.00	1.00	NO	FORM HOLE IN CAVITY WALL OR 1 BRICK WALL & BUILD IN A.G	7.82	2.25	0.00	0.00	10.07
290	LAB	11	LABX	2.66	1.50	M.CU	WHEEL MATERIAL UP TO 40 M. AND DEPOSIT IN SKIP	14.48	0.00	0.00	0.00	14.48
							PAGE TOTALS	285.67	79.71	0.00	0.00	365.39

REF	TRAD	NO	TARG	OUTPUT	QUANTITY	UNIT	DESCRIPTION	LAB. COST	MAT. COST	PLT. COST	SCN. COST	TOTALS
295	LAB	62	LABX	1.00	3.56	M.SQ	TAKE DOWN EXTERNAL ONE BRICK W ALL	12.92	0.00	0.00	0.00	12.92
296	CARP	754	CAR2	0.25	1.68	M	TAKE DOWN RAINWATER PIPE	1.56	0.00	0.00	0.00	1.56
301	BLR	92	BLRX	0.33	10.00	M	RAKE OUT JOINT & POINT VERGE	12.90	3.00	0.00	0.00	15.90
309	LAB	70	LABX	0.60	6.20	M.SQ	HACK UP BRICK PAVING	12.35	0.00	0.00	0.00	12.35
310	LAB	69	LABX	6.00	0.50	M.CU	CONCRETE 300 THICK & WHEEL UP TO 30M	9.96	14.50	0.00	0.00	24.46
311	LAB	68	BLRX	1.85	3.80	M.SQ	RAKE OUT JOINT & POINT STACKS	27.48	0.38	0.00	0.00	27.86
315	BLR	93	BLRX	2.90	3.00	M.SQ	ONE BRICK WALL FACED BOTH SIDE S	34.01	48.60	0.00	0.00	82.61
325	LAB	9	LABX	1.33	0.75	M.CU	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	3.62	0.00	9.27	0.00	12.89
330	SUBC	2	SUBC	0.00	1.00	NO	ALL ELECTRICAL WORK	0.00	0.00	0.00	380.00	380.00
335	SUBC	3	SUBC	0.00	1.00	NO	ALL PLASTERING WORK	0.00	0.00	0.00	889.00	889.00
340	SUBC	4	SUBS	0.00	1.00	NO	ALL PAINTING WORK	0.00	0.00	0.00	610.00	610.00
							TOTALS #	1624.96	1044.37	67.78	4007.00	6744.13

REF	DESCRIPTION	QUANT	UNIT	TOTALS
5	BREAK UP UNREINFORCED CONCRETE 150 THICK	4.00	M.SQ	20.71
6	OVERSITE CONCRETE 150 THICK	0.60	M.CU	36.42
7	DAMP PROOF MEMBRANE	4.00	M.SQ	2.17
9	ARDIT SCREED	4.00	M.SQ	12.95
10	STRIP OFF PLASTER FROM WALLS - SOFT	34.00	M.SQ	64.17
11	TAKE OUT FIREPLACE, SURROUND & HEARTH	2.00	NO	17.26
12	TAKE OUT KITCHEN UNITS & FITTINGS	1.00	NO	12.94
14	DISCONNECT & REMOVE GAS COOKER	1.00	NO	4.31
15	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	1.33	M.CU	29.02
16	CHEMICAL INJECTED DPC	1.00	NO	309.40
20	SKIRTINGS OVER 100 DEEP	33.00	M	75.58
22	PLUMBING & HEATING	1.00	NO	2457.00
25	PIPE BOXING TO WATER PIPES	5.00	M	41.34
30	TAKE OUT WINDOW & PREPARE OPENING FOR NEW	36.00	M	60.38
31	TAKE OUT STONE OR CONCRETE SILL	2.00	M	10.16
32	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	0.60	M.SQ	24.67
33	REFIX CONCRETE OR STONE SILL	2.00	M	10.94
34	FILLING RECESSES TO SQUARE OFF JAMBS	24.77	M	85.34
35	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING	1.12	M	6.78
36	SUPPLY ONLY SINGLE GLAZING	1.00	NO	102.02
40	FIXING WINDOWS	31.00	M	38.69
45	SUPPLY ONLY WINDOWS	1.00	NO	268.76
55	MASTIC POINTING	32.17	M	44.83
60	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS	39.00	M	49.55
65	WINDOW BOARDS ON BEARERS	6.42	M	35.09
			PAGE TOTAL #	3820.61

Figure A4.3. ESTIMATE PRODUCED FOR CLIENT.

REF	DESCRIPTION	QUANT	UNIT	TOTALS
75	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	1.00	M.CU	22.84
80	INTERNAl DOOR INCLUDING MORTICE LATCH FURNITURE	8.00	NO	167.64
81	ARCHITRAVES OVER 100 WIDE	5.00	M	7.16
85	FIT DOOR STOPS	2.00	NO	3.19
86	COLLECT UNITS FROM SUPPLIER (ONE JOURNEY)	1.00	NO	5.08
90	HALF BRICK WALL IN FILLING OPENINGS UP TO 1 SQ.M	1.68	M.SQ	20.99
95	MAKE GOOD FLOOR OR CEILING WHERE PARTITION REMOVED	6.00	M	34.39
101	STRIP OFF PLASTER FROM WALLS - SOFT	49.56	M.SQ	85.56
102	WHEEL MATERIAL UP TO 40 M. AND DEPOSIT IN SKIP	1.20	M.CU	52.36
103	SKIRTINGS OVER 100 DEEP	1.80	M	4.12
104	TAKE DOWN STUD PARTITION	2.02	M.SQ	3.48
105	STUD PARTITION	59.00	M	119.80
106	CONSTRUCT WINDOWS ON SITE FROM FRAMING	3.67	M	17.88
107	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS	3.50	M	4.44
108	TAKE OUT FIREPLACE, SURROUND & HEARTH	4.00	NO	34.52
110	AIRING CUPD OF 1 SIDE & FRONT BUILT UPO FROM STD UNITS & BBD	1.00	NO	112.58
115	TAKE OUT ROOF LIGHT UP TO 1 SQ.M	1.00	NO	7.62
120	TAKE OFF SLATES TO FORM OPENING UP TO 2M.SQ	26.00	NO	13.21
122	SUPPLY ONLY ROOF LIGHT & FLASHINGS	1.00	NO	165.51
123	TRIM OPENING FOR ROOF LIGHT	5.00	M	16.70
125	FIX VELUX ROOFLIGHT & FLASHING(BASED ON PERIMITER OF ROOFL'T	5.00	M	355.81
130	SECURE RAFTERS TO CEILING JOISTS WITH M.S.STRAPS	12.00	NO	31.82
135	TAKE OFF EXTERNAL DOOR & FRAME & PREPARE FOR NEW FRAME	1.00	NO	5.73
140	FIX NEW EXTERNAL DOOR FRAME	1.00	NO	43.31
145	FIX EXTERNAL DOOR COMPLETE WITH MORTICE LOCK & BOLT	1.00	NO	43.31
			PAGE TOTAL £	1439.82

REF	DESCRIPTION	QUANT	UNIT	TOTALS
155	TAKE DOWN SHELVING	5.50	M	4.74
160	RM HOLE FOR & FIX LETTER BOX & INNER FLAP	1.00	NO	15.78
170	FIX HOUSE NUMBERS	4.00	NO	4.67
171	TAKE OFF HANDRAIL	3.50	M	2.11
172	FIX HANDRAIL	3.20	M	26.68
173	FIX FLOOR BOARDS IN ISOLATED AREAS	5.00	M.SQ	70.62
175	TAKE UP FLOOR BOARDS	5.00	M.SQ	30.25
180	SKIRTINGS OVER 100 DEEP	5.80	M	21.42
185	FIXING EXTERNAL DOOR,LOCK & 2 NO BOLTS	1.00	NO	68.49
190	FIXING WEATHER BOARD TOP DOOR	1.00	NO	7.67
195	TAKE DOWN WALL BOARDING	11.75	M.SQ	13.86
200	HACK OFF WALL TILES	2.75	M.SQ	6.48
205	FORM SOLID BALUSTRADE USING PLY DOORS	5.00	M.SQ	27.15
210	CAPPING TO TIMBER PANEL	3.00	M	13.70
211	SKIRTINGS OVER 100 DEEP	8.26	M	18.92
215	225 WIDE SHELVING INCLUDING BEARERS & BRACKETS	1.00	M	4.52
216	TILE SPLASH BACK & SILLS	2.30	M.SQ	71.46
220	TAKE OUT FLOOR JOISTS	4.00	M	5.08
225	100 X 50 BEARER SECURED TO WALL AS SUPPORT FOR JOIST	3.00	M	11.13
230	CUT OFF ENDS OF JOISTS & SUPPORT TEMPORARILY	6.00	NO	9.96
235	FIX JOIST HANGARS INTO EXISTING WALL	6.00	NO	24.21
236	GROUND FLOOR JOISTS	3.67	M	11.52
240	TAKE DOWN TIMBER GUTTER	6.42	M	10.76
245	FIX TIMBER GUTTER	6.42	M	46.07
250	OUTLET TO TIMBER GUTTER AND JOINT TO RWP	1.00	NO	6.38
			PAGE TOTAL #	538.07

REF	DESCRIPTION	QUANT	UNIT	TOTALS
255	SHOE TO PVC RWP	1.00	NO	2.44
260	RAKE OUT JOINTS & POINT BRICKWORK - SOFT MORTAR	23.30	M.SQ	151.07
265	REPOINT RIDGE OR HIP TILES	5.00	M	17.81
270	REPLACE DAMAGED SLATES IN AREAS UP TO 1 M.SQ	10.00	NO	25.70
275	BREAK UP ASPHALT AND BASE 50MM THICK	10.00	M.SQ	31.14
285	FORM HOLE IN CAVITY WALL OR 1 BRICK WALL & BUILD IN A.G	1.00	NO	13.09
290	WHEEL MATERIAL UP TO 40 M. AND DEPOSIT IN SKIP	1.50	M.CU	18.82
295	TAKE DOWN EXTERNAL ONE BRICK WALL	3.56	M.SQ	16.73
296	TAKE DOWN RAINWATER PIPE	1.60	M	2.03
301	RAKE OUT JOINT & POINT VERGE	10.00	M	20.67
309	HACK UP BRICK PAVING	6.20	M.SQ	16.05
310	CONCRETE 300 THICK & WHEEL UP TO 30M	0.50	M.CU	31.79
311	RAKE OUT JOINT & POINT STACKS	3.80	M.SQ	36.22
315	ONE BRICK WALL FACED BOTH SIDES	3.00	M.SQ	107.40
325	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP	0.75	M.CU	16.76
330	ALL ELECTRICAL WORK	1.00	NO	494.00
335	ALL PLASTERING WORK	1.00	NO	1155.70
340	ALL PAINTING WORK	1.00	NO	793.00
		TOTALS ‡		8767.36

TARGET SHEET FOR PROVID, TARGET SECTION CAR1

EST REF	DESCRIPTION	TARGET - HRS
106	CONSTRUCT WINDOWS ON SITE FROM FRAMING	
236	GROUND FLOOR JOISTS	
32	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	
34	FILLING RECESSES TO SQUARE OFF JAMBS	
123	TRIM OPENING FOR ROOF LIGHT	
	TOTALS	219

TARGET SHEETS FOR PROVID TARGET SECTION CARX

EST REF	DESCRIPTION	TARGET - HRS
240	TAKE DOWN TIMBER GUTTER	
245	FIX TIMBER GUTTER	
250	OUTLET TO TIMBER GUTTER AND JOINT TO RWP	
255	SHOE TO PVC RWP	
251	PVC PAINWATER PIPE	
	TOTALS	11

Figure A4.4. TARGET SHEET FOR OPERATIVE FOR TARGET SECTIONS CARPENTRY FIRST FIX AND CARCASSING.

TARGET SHEETS FOR PROVID TRADE BLR 1

EST. REF.	DESCRIPTION	TARGET - HRS
285	FORM HOLE IN CAVITY WALL OR 1 BRICK WALL & BUILD IN A.G	
35	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING	
260	RAKE OUT JOINTS & POINT BRICKWORK - SOFT MORTAR	
31	TAKE OUT STONE OR CONCRETE SILL	
33	REFIX CONCRETE OR STONE SILL	
90	HALF BRICK WALL IN FILLING OPENINGS UP TO 1 SQ.M	
32	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	
301	RAKE OUT JOINT & POINT VERGE	
315	ONE BRICK WALL FACED BOTH SIDES	
	TOTALS	58

Figure A4.5. TARGET SHEET FOR OPERATIVE FOR TRADE, BRICKLAYER.

TARGET SHEETS FOR PROVID TARGET SECTION CAR1

EST REF	DESCRIPTION			TARGET - HRS	
30	TAKE OUT WINDOW & PREPARE OPENING FOR NEW			11.88	
		36.00 M	0.33 Hours/M		13.06
35	CUT TOOTH AND BOND 1 BRICK OR CAVITY WALL TO EXISTING			1.12	
		1.12 M	1.00 Hours/M		1.23
40	FIXING WINDOWS			6.82	
		31.00 M	0.22 Hours/M		7.50
55	MASTIC POINTING			6.43	
		32.17 M	0.20 Hours/M		7.07
60	SINGLE GLAZING (BASED ON TOTAL PERIMETER OF GLASS			9.75	
		39.00 M	0.25 Hours/M		10.72
65	WINDOW BOARDS ON BEARERS			3.21	
		6.42 M	0.50 Hours/M		3.53
70	TAKE OFF INTERNAL DOOR AND MAKE GOOD LINING			8.00	
		8.00 NO	1.00 Hours/NO		8.80
75	WHEEL MATERIAL UP TO 20 M. AND DEPOSIT IN SKIP			1.33	
		1.00 M.CU	1.33 Hours/M.CU		1.46
80	INTERNAL DOOR INCLUDING MORTICE LATCH FURNITURE			16.00	
		8.00 NO	2.00 Hours/NO		17.60
95	MAKE GOOD FLOOR OR CEILING WHERE PARTITION REMOVED			6.00	
		6.00 M	1.00 Hours/M		6.60
105	STUD PARTITION			11.80	
		59.00 M	0.20 Hours/M		12.98
115	TAKE OUT ROOF LIGHT UP TO 1 SQ.M			1.50	
		1.00 NO	1.50 Hours/NO		1.65
120	TAKE OFF SLATES TO FORM OPENING UP TO 2M.SQ			2.60	
		26.00 NO	0.10 Hours/NO		2.86
125	FIX VELUX ROOFLIGHT & FLASHING(BASED ON PERIMITER OF ROOFL'T			70.00	
		5.00 M	14.00 Hours/M		77.00
130	SECURE RAFTERS TO CEILING JOISTS WITH M.S.STRAPS			3.96	
		12.00 NO	0.33 Hours/NO		4.35
135	TAKE OFF EXTERNAL DOOR & FRAME & PREPARE FOR NEW FRAME			1.00	
		1.00 NO	1.00 Hours/NO		1.10
140	FIX NEW EXTERNAL DOOR FRAME			1.00	
		1.00 NO	1.00 Hours/NO		1.10

Continued Overleaf.

Figure A4.6. TYPICAL TARGET SHEET FOR MANAGEMENT USE FOR TARGET SECTION FIRST FIX, CARPENTRY.

TARGET SHEET FOR PROVID, TARGET SECTION CAR1

EST REF	DESCRIPTION	TARGET - HRS	
160	RM HOLE FOR & FIX LETTER BOX & INNER FLAP	2.00	
	1.00 NO 2.00 Hours/NO		2.20
170	FIX HOUSE NUMBERS	0.48	
	4.00 NO 0.12 Hours/NO		0.52
220	TAKE OUT FLOOR JOISTS	1.00	
	4.00 M 0.25 Hours/M		1.10
225	100 X 50 BEARER SECURED TO WALL AS SUPPORT FOR JOIST	1.50	
	3.00 M 0.50 Hours/M		1.65
230	CUT OFF ENDS OF JOISTS & SUPPORT TEMPORARILY	1.50	
	6.00 NO 0.25 Hours/NO		1.65
235	FIX JOIST HANGARS INTO EXISTING WALL	3.00	
	6.00 NO 0.50 Hours/NO		3.30
31	TAKE OUT STONE OR CONCRETE SILL	2.00	
	2.00 M 1.00 Hours/M		2.20
33	REFIX CONCRETE OR STONE SILL	2.00	
	2.00 M 1.00 Hours/M		2.20
106	CONSTRUCT WINDOWS ON SITE FROM FRAMING	2.93	
	3.67 M 0.80 Hours/M		3.22
236	GROUND FLOOR JOISTS	0.55	
	3.67 M 0.15 Hours/M		0.60
32	BRICKWORK IN RAISING SILLS IN ONE BRICK WALL	2.40	
	0.60 M.SQ 4.00 Hours/M.SQ		2.64
34	FILLING RECESSES TO SQUARE OFF JAMBS	13.62	
	24.77 M 0.55 Hours/M		14.98
123	TRIM OPENING FOR ROOF LIGHT	2.50	
	5.00 M 0.50 Hours/M		2.75

TOTALS 198.89

FACTOR 1.10 FACTOR TOTAL 218.78