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THE UNIVERSITY OF ASTON IN BIRMINGHAM

DEPARTMENT OF CONSTRUCTION AND ENVIRONMENTAL HEALTH

AN ANALYSIS OF THE UTILITY OF

BILLS OF QUANTITIES IN THE PROCESS

OF BUILDING CONTRACTING

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,
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DOCTOR OF PHILOSOPHY

by

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SUMMARY

AN ANALYSIS OF THE UTILITY OF BILLS OF QUANTITIES

IN THE PROCESS OF BUILDING CONTRACTING

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Ph.D.

1979

The building contractor is dependent upon information supplied by designers in order to price and plan his work, deploy resources and set up control procedures necessary for the prosecution of the contract.

The bill of quantities is an important information source which provides the financial link between the client and his contractor. However, despite the fact that the primary objective of the bill is that of a tender document, once the contract is let, it serves management in the planning, buying and manufacturing procedures.

The research examines the bill of quantities as an information source for the contractor and discovers that the information could better serve the many functions of contracting in addition to that of tendering and payments.

The criteria by which the utility of information given in the bill is judged are format, adequacy and independence. Format refers to the way in which information is presented. Adequacy refers to whether a contractor must make additional allowances in order to make use of the information. Independence refers to the ability of information to satisfy the contractor's requirements without reference to additional information sources.

The utility of the bill in its service to the contracting process is established by expert judges in the principal study. The conclusions reached in the principal study are then submitted to a larger sample of expert opinion for validation. The validation is subdivided into two groups, contractors' quantity surveyors, and others, who are shown to differ in their views on some matters. It is concluded that the bill serves contracting to a far greater extent than may previously have been supposed, and that enormous potential exists for the wider use of quantified and specification data.

MEASUREMENT CONTRACTING INFORMATION

BILLS OF QUANTITIES QUANTITY SURVEYING

A C K N O W L E D G E M E N T S

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CHAPTER I

INTRODUCTION

C H A P T E R I

INTRODUCTION

The bill of quantities was, in the first place, devised to afford a fair basis of comparison of tenders for the purpose of contractor selection. The implications which arise from the provisions established within a contracting organisation in order to facilitate success in gaining selection of the company's tender are:

- (i) that the tender sum constitutes the product of a reliable estimate of the works, and also provision for such overheads and profit that the firm is duly rewarded for its effort and the client gains his works at a fair market price.
- (ii) that the interpretation of the documents by competing contractors is unlikely to be significantly different.
- (iii) that the work of the estimator reflects the expense and effort of the contractor (i.e. that commercial and production experience interacts through the firm's control systems and procedures with the estimator's judgements).

A billing procedure which deals in different terms from commercial and production procedures has to be reinterpreted in order to compare forecast price with actual cost. If the two cannot be readily reconciled then the estimator's practice may adopt an empirical model based more on experience of tendering success than on the precision with which items of work can be priced.

It is to the benefit of the industry's clients that its system of pricing should be both fair and uncomplicated. Complication in data gathering, analysis and feed-back adds to overheads and thus costs, or encourages the adoption of approximate methods which may thus call for an increase in the margin necessary to cover risks.

This research is concerned to identify the extent to which the bill of quantities satisfies the needs of the building contractor and thereby serves the client, and, in view of the fact that other major countries of the world do not use a bill, whether or not its continued use may be justified.

The object of the research is to analyse the service of the bill to the building contracting process and identify whether or not information is presented in a format which satisfies specific uses, and whether the content of information is considered to be appropriate to the various demands made upon it. The research also seeks to discover whether or not the bill represents to the contractor an independent source of data. These

three facets of the information, format, adequacy and independence are established in the research as being the criteria upon which the utility of the information is judged.

CHAPTER II

DEVELOPMENTS AND PRACTICE IN TENDERING

AND MEASUREMENT

C H A P T E R I I

DEVELOPMENTS AND PRACTICE IN TENDERING AND MEASUREMENT

2.1 The British Construction Industry

2.1.1 Historical Developments

The Industry from the Middle Ages until the seventeenth century was of a guild or craft type structure.⁽¹⁾ The system was slow to change. Until the end of the seventeenth century clients superintended their own building since large scale building was undertaken by the few and the wealthy.⁽²⁾

It was the occurrence of the Great Fire of London in 1666 that initiated change in the structure of the industry.⁽³⁾ The enormous and immediate requirement for buildings was too great a demand to be met by the guild system. "The rebuilding of London and the emphasis upon the urban growth raised the status of the itinerant craftsmen and labourers,"⁽⁴⁾ who began to offer both labour and the provision of material. Building costs were agreed between owners and craftsmen on a quantities basis, measured and valued after the completion of the work.⁽⁵⁾ Thus these new commercial building units tended to centre around the new enterprising master craftsmen.⁽⁶⁾

The emergence of these enterprising master craftsmen gave rise to the need for pre-contract estimating and in this respect quantities had a useful part to play. During this period published works on measurement⁽⁷⁾ gave standard quantities and rates for houses and described the measurement process. Flanagan wrote, "the mere fact that Leybourn had written a section in his book for the Measurer, implies that measurement was becoming the accepted practice."⁽⁸⁾

In 1835 a correspondent to the Architectural Magazine complained of abuses in contracting method and the differences between estimates and final accounts. He proposed a procedure whereby the architect prepared sketch plans, working drawings and specifications in full.⁽⁹⁾

He added:-

"beside these papers, before works are begun, the architect or builder should supply a blank bill of quantities; and this bill of quantities should be furnished by the architect, if the works are to be contracted for, to each contractor. A good will result from this mode of proceedings; and I believe it is adopted by some architects. The building industry would then reap the benefits of accurate quantities and have a sound basis for pricing variations."⁽¹⁰⁾

The design and building of the Houses of Parliament, following the destruction of the Palace of Westminster by fire in 1834, became the biggest public building project of the age, and a great land mark in the history of contracting and quantity surveying.⁽¹¹⁾ A detailed

estimate, based upon a bill of quantities, was prepared by Hunt, and accepted as being the likely cost of the new building.⁽¹²⁾ The major part of the building work proper was contracted for by a single firm of building contractors, Grissell and Peto, under a contract in gross.⁽¹³⁾ Referring to the final account figures Thompson writes, "The out-turn was a most substantial vindication for the system of quantity surveying and contracting in gross."⁽¹⁴⁾ Although this contract pinpoints the formal debut of the modern bill, it does not identify the consummation of a systemic growth, or even the start of a period of steady progress.⁽¹⁵⁾ Many people opposed the new age of competition, and saw it as an evil practice.⁽¹⁶⁾

By the middle of the nineteenth century the practice of a main contractor acting as co-ordinator for other contractors had given place to the general contracting companies which became the predominant part of the building industry.⁽¹⁷⁾ An important event which stimulated the replacement of building craft firms by general contracting companies "was a regulation issued by the Government during the Napoleonic Wars. To encourage economy and despatch, each job had to be under the control of one responsible contractor."⁽¹⁸⁾ With the emergence of the general contractor, the practice of competition grew,⁽¹⁹⁾ and with competition, the bill of quantities was assimilated into the building process through the demands of the building firms, who entering into competition, required a reliable basis for estimating and the framework of contract within which to pursue the work.⁽²⁰⁾

By the middle of the nineteenth century 'measurers' had given way to quantity surveyors.⁽²¹⁾ This development was a direct response to the need to find a common basis for comparing the bids

of main contractors for jobs.⁽²²⁾ Enterprising surveyors developed the process of measuring from drawings, and bills of quantities resulted. By the end of the nineteenth century it was well recognised by many surveyors that uniformity in measurement procedures must be achieved.⁽²³⁾

By 1913 a committee had been established to investigate methods of measurement.⁽²⁴⁾ Although the committee made good progress, the outbreak of war hindered the publication of their work. "The first edition of the Standard Method of Measurement was published in 1922, and with its adoption, the modern bill of quantities had finally evolved."⁽²⁵⁾

2.1.2 Bills of Quantities

Since 1922 five editions of the Standard Method of Measurement of Building Work have been published.⁽²⁶⁾ Each of these editions has embodied the concept of work measured as it is fixed in position and inclusive of labour and material. The revisions introduced with each edition have reflected the problems and deficiencies identified with use, and the demands imposed by changing technology and new materials. The first four editions of the Standard Method were presented in a trade by trade format, but with the fifth edition the standing joint committee took a more fundamental view.⁽²⁷⁾ The trade by trade format was replaced by work sections each with a single unit of billing. "The use of standard phrases and a system of general clauses led to a clearer, more flexible, and more comprehensive document."⁽²⁸⁾

Bills of quantities have come to be a contract document. They conform to the general principles of the Standard Method of Measurement for Building Works.⁽²⁹⁾ Traditionally the information in the bill of quantities has been arranged in a 'trade' sequence, so that all the work relating to one trade is grouped together.⁽³⁰⁾ Trade by trade presentation assists sub-trade quotations and facilitates the submission of competitive tenders.⁽³¹⁾ The consequence of this status is that the bills are required to describe the works with sufficient clarity to permit the adjudication of disputes and the settlement of issues regarding entitlement to payment.

In the early 1950's the 'elemental bill' was introduced in which measured work was grouped into functional elements, each element further subdivided into trades.⁽³²⁾

The purpose of the elemental bill format was to provide a direct response to the growing publicity given to cost planning by the Department of Education.⁽³³⁾ One problem with the elemental bill was, however, that similar items of work were widely distributed, making pricing a more time consuming process. In 1956 the use of the elemental bill was investigated. The committee concluded:

"The reaction of builders generally is at the present unfavourable to the elemental bill of quantities chiefly on the grounds that tendering is made more complicated."⁽³⁴⁾

To answer these criticisms the sectionalised trade bill was introduced.⁽³⁵⁾ For the purpose of tendering, the presentation of

the bill followed a trade sequence, each trade being subdivided into elements. For the purpose of contract management, the bill could be re-collated into an elemental format with each element subdivided into trades.⁽³⁶⁾ Although objections raised against the elemental bill were in part avoided in this format, it was not widely used.

The problem of presentation and format of information in bills of quantities was considered by a working party in 1959.⁽³⁷⁾

With reference to elemental and sectionalised trade bills it concluded that neither form appeared to be susceptible to amendment which would enable contractors to relate site costs to bill prices.⁽³⁸⁾ The working party recommended further research into the presentation and format of bills of quantities and observed that the improved usefulness of data to the industry as a whole may well be the factor to justify any revisions.⁽³⁹⁾ The prevailing thought regarding bills of quantities at this time was toward a contractor orientated document. The Banwell report recognised that bills of quantities were devised primarily for tendering and allied purposes but this should not be their only function.⁽⁴⁰⁾

Higgin and Jessop recorded that, "some different presentation of information to the builder could help materially in enabling us to plan our work and control costs."⁽⁴¹⁾

Nisbet stated:-

"Because buildings are bigger and more complex, the planning and co-ordination of site operations is now a major task. For any large project this has to be done by special planning departments in the builder's organisation. This work usually involved the planning departments in taking off quantities, an operation which of course has already been done by the quantity surveyor. There is nothing sacrosanct in the way we present our quantities and if we can offer a bill of quantities which helps the planning department as well as the estimator we shall be improving our service to the builder."⁽⁴²⁾

In 1965 a further working party was established by the Royal Institution of Chartered Surveyors to investigate the possibility of standardisation of information in bills of quantities and the possibility of using the information they contain for purposes other than tendering, including costing, bonusing, ordering, programming, estimating and pricing.⁽⁴³⁾ Their report concluded that the traditional bill could be improved to cater for additional requirements if the information contained in the normal taking-off could be reflected in the document. 'Locational bills' would in their opinion reflect the items which applied to site layout and operations of construction. The work sections therefore most likely to be affected by 'locational bills' would be excavation and earthwork, and concrete work.⁽⁴⁴⁾ These two sections of the Standard Method of Measurement for Building Work include all excavation work, disposal, planking and strutting, reinforced and unreinforced concrete work, formwork and reinforcement.⁽⁴⁵⁾

The working party also recommended that urgent consideration be given to the development of standard descriptions for items in bills of quantities.⁽⁴⁶⁾ In response to this Fletcher and Moore produced a standard phraseology for bills of quantities,⁽⁴⁷⁾ subsequently recommended by the Royal Institution of Chartered Surveyors for general use by quantity surveyors.⁽⁴⁸⁾ This work was a fundamental contribution toward standardisation within bills of quantities although it played no part in producing information for a wider use.

The work of Ferry and Holes⁽⁴⁹⁾ was a critical examination of the pattern of use for measured information within the construction industry. It also discussed the possibility of developing a single integrated system of measurement. Although this work was at the conceptual level, it identified the requirement of measured information within the contracting company and recognised the need to develop a system which could satisfy this requirement from basic measurement.⁽⁵⁰⁾

The Potts report stated that "the measurement and make up of bills do not always reflect the cost of operations." "A move toward operational bills, which the Building Research Station is currently examining, may help."⁽⁵¹⁾

A new concept for the preparation and presentation of measured information known as the Operational Bill⁽⁵²⁾ was developed in the 1960's by the Building Research Station, now the Building Research Establishment.

The traditional concept of measuring building work net as fixed in position inclusive of labour, material, plant, overheads and profit was set aside for a new method in which labour and material were measured separately.

The production of an Operational Bill required the analysis of the proposed building into operations, each identified with a recognised working group such that an item would be connected with a specific responsibility for its completion. These operations were next arranged sequentially with the aid of a precedence diagram, and formed the basic structure which information followed in the bill. Each operation was further subdivided into its labour and material elements, the material element being grouped either operationally, or as part of a total material schedule and cross referenced to its operation. A further separate schedule of factory made components was also produced.⁽⁵³⁾ The aim of the Operational Bill was to aid estimating and production and provide the framework for "effective feedback of cost information between construction, estimating and design."⁽⁵⁴⁾ The concept of time was an important consideration in planning the precedence and on the estimation of labour, plant and overheads.⁽⁵⁵⁾

However, a number of major problems appear to emerge with the method, firstly the discipline imposed upon architects to arrange and present drawings in a way compatible with the operational concept, secondly, the identification of operations for different building projects, thirdly, the difficulty of relating financial experience gained on one contract to another.⁽⁵⁶⁾

These problems were largely countered by the introduction of a bill of quantities operational format, measured in accordance with the Standard Method of Measurement for Building Works. The result was significant duplication of effort. The bills were lengthy and there was a risk of tactical decisions being made which might cause work to be done in some other sequence than that planned.

Ten years after the introduction of operational bills, Mr. Skoyles confessed that the low response to the bill, particularly in the field of competitive tendering, was disappointing.⁽⁵⁷⁾

"It cannot be denied that tenders are being obtained daily in large numbers with no problems" but "the ideal document should be able to obtain equitable tenders cheaply and with a realism which will enable a design which considers the process of production, to be isolated from one which creates complexities. Items which are measureable only in terms of time should be priced in terms of time, and materials which have to be ordered should be presented in the terms for ordering to save duplication of work."⁽⁵⁸⁾

2.1.3. Civil Engineering Bills of Quantities

Although this research is primarily concerned with bills of quantities for building work, the British survey would be incomplete without reference to the significant changes which have taken place over the past decade in civil engineering bills of quantities.

In 1968 the Economic Development Committee for Civil Engineering wrote, "one of the weaknesses of the Banwell report⁽⁵⁹⁾ in our opinion is that it did not differentiate sufficiently between 'building' and 'civil engineering'."⁽⁶⁰⁾ "Whatever may lie ahead we are convinced that for the present and for some time to come 'building' and 'civil engineering' must be treated separately."⁽⁶¹⁾ Just as one should regard building and civil engineering as separate functions, so also should the individuality of the bills of quantities and their methods of measurement be recognised.

In 1968 it was identified that research was being carried out at the University of Manchester Institute of Technology on the use of 'activity bills' in civil engineering.⁽⁶²⁾ In 1971 Barnes and Thompson completed a study of civil engineering bills of quantities⁽⁶³⁾ and Barnes submitted an individual thesis relating to experimental bills of quantities.⁽⁶⁴⁾ The result of this research was the 'method-related' bill.

A number of concepts new to civil engineering bills of quantities were developed. The bill followed a standard layout and content. The work items were further subdivided according to their location, activity or any other circumstance as cost significance may dictate. In addition to the conventional quantity proportional charges, fixed and time related charges were introduced. The contractor was also given the opportunity of adding any additional item in the categories of fixed and time related items, as he may require.

The bill contains six principal divisions of information.⁽⁶⁵⁾ Firstly a summary of the main quantities, which does not form part of the contract. This is followed by a number of special preamble clauses which identify the special nature of the bill, the form of contract to be used, and the method of measurement. These also define quantity proportional, fixed and time related charges and state how the different charges are used in the contract.

The third item is the precedence diagram. This is included when the quantity proportional charges are grouped into activities. The precedence is not intended to be a programme.

The fourth division of information is the main summary. The main summary is followed by the fixed and time related charges. "The test used to decide whether a cost element should be covered by a time-related or fixed charge is whether or not variation in quantity of permanent work will cause a proportional variation in the cost element concerned."

The final area of information is the measured work. This may be subdivided into activities if the contract so requires, or it may follow the divisions of the Standard Method of Measurement.

The advantages claimed for this bill were:-

1. Improved financial control of civil engineering activity with reduced administrative costs.
2. Payment for work done more equitable to both parties.

3. Less contention and delay in agreeing
payment.⁽⁶⁶⁾

Based upon the work of the method-related bill Barnes was invited by the Institution of Civil Engineers to work on the revision to the Standard Method of Measurement of Civil Engineering. In 1976 a new Civil Engineering Standard Method of Measurement was published incorporating the method related concept.⁽⁶⁷⁾ However, this method of measurement achieved more than the introduction of method related charges. Its status has been described as a code of practice.⁽⁶⁸⁾ Its definitions, procedures and instructions for preparing bills of quantities establish order and uniformity for its users, and the work classification, which is the framework and structure of the Civil Engineering Standard Method of Measurement, forms the main instrument by which co-ordination of various financial control functions is fostered.⁽⁶⁹⁾ There are features, such as the dependence upon drawings and specification (which form part of the contract documentation) in framing descriptions of items, which, if translated to building, would call for changes of professional procedure. The number of work classifications would also have to be enlarged.

2.1.4. Data Co-ordination

Following the widespread interest aroused by the pilot study into communications in the building industry,⁽⁷⁰⁾ the National Consultative Council of the Ministry of Public Building and Works,

now the Department of the Environment, established a working party to investigate data co-ordination within the construction industry. A report⁽⁷¹⁾ was published, in which the work of many sub-groups was summarised to show the advantage of a rationalised system of information. One point emphasised as being an important advantage of co-ordination was the provision of better management information to designers, constructors and suppliers.⁽⁷²⁾ In their final report, the working party concluded upon the work of one sub-group that had considered the structuring of project information, and stated that "the development of an improved and standardised structure for project information was one of the highest priorities for data co-ordination."⁽⁷³⁾

Specifically, the working party dealing with structuring project information concluded that further specific work was required "to ascertain users and producers information needs in greater depth".⁽⁷⁴⁾ With specific regard to bills of quantities they also concluded that "the possibility of providing documents which facilitate the separation of the tender/payment and the production control functions of the bill of quantities should be investigated."⁽⁷⁵⁾

These conclusions emphasise the need to understand where and what information is used, and how well suited existing information is to individual requirements.

In 1971 a joint committee of members of the Royal Institution of Chartered Surveyors and the National Federation of Building Trades

Employers was established to examine the question of whether the concept of measurement embraced within the existing Standard Method of Measurement of Building Works could be extended into areas of production, planning and control. Their report⁽⁷⁶⁾ took account of research work and public opinion and concluded that "it was of the utmost importance that the bill of quantities should reflect the financial relevance of organisational and managerial issues."⁽⁷⁷⁾

It is significant that following the publication of this report a Standard Method of Measurement Development Unit was formed.

2.1.5 The Standard Method of Measurement

The interim report made by the Standard Method Development Unit to their sponsors,⁽⁷⁸⁾ confirmed the intention to publish a sixth edition of the Standard Method of Measurement of Building Works to serve as an intermediate step between current practice and the proposals discussed in the Measurement Conventions⁽⁷⁹⁾ report which concluded that "bills of quantities should separately identify items with regard to the characteristics of quantity; time; occurrence and value",⁽⁸⁰⁾ and that primary measurements taken by the quantity surveyor should be made available to the contractor.⁽⁸¹⁾

The fifth edition (metric) of the Standard Method of Measurement of Building Works, currently used by practice, has a very limited function. "it is a method of measurement intended to produce a

satisfactory tender document and one to be used in connection with valuation of variations under the contract. It is not intended to be a specification, a demarcation of trades, a method of billing, a system of classification, a materials ordering list, etc."⁽⁸²⁾ However, "the Standard Method of Measurement in its present form is a compromise that satisfied hardly anyone, and the parties to it are accordingly busy studying methods of bringing it up to date and making it more useful."⁽⁸³⁾ It is intended that revision to the Standard Method of Measurement will take account of the criticism stemming from three sources. Firstly from quantity surveyors and estimators, secondly from other members within the construction industry and thirdly from outside the industry where the Standard Method of Measurement has an indirect influence on the procurement roles of commerce, industry and government.⁽⁸⁴⁾

It is envisaged that a new method of measurement would recognise various sets of rules identifying the different degrees of quantification required by different sectors of interest at successive stages.⁽⁸⁵⁾ "This introduces a totally new concept to our procedures".⁽⁸⁶⁾ From the clients viewpoint, and the effects on quantity surveying, the introduction of such changes must serve to provide "better cheaper or quicker buildings."⁽⁸⁷⁾

By identifying the state of completeness of design, contractors will be given a better opportunity to estimate the risks involved with variations to design. A standard format for tender documents controlled by a method of measurement would assist contractors,

particularly at tender stage. If the project data presented in bills of quantities is to be used by planners, buyers, production engineers and others, then measurements must be guaranteed.⁽⁸⁸⁾

In a rapidly changing world "we are likely to be faced with a greater variety of different situations than in the past. The new S.M.M. will be designed to equip us to deal with the world as it is rather than as it used to be".⁽⁸⁹⁾

The sixth edition of the Standard Method of Measurement of Building Works* is seen as a transition between the fifth edition and the major changes planned for the seventh edition.⁽⁹⁰⁾ There is no evidence of research similar to that now contained herein which served to guide the transition from the fifth to the proposed seventh edition. It is valid therefore to review the utility of the fifth edition and to measure the relevance of proposed changes against its findings. The sixth edition retains the trade order, the general format and language. The major revisions affect the excavation, concrete work, and brickwork sections, and a new woodwork section combines the carpentry and joinery sections,⁽⁹¹⁾ other revisions are of a minor nature. It is considered that resulting from the introduction of the sixth edition, bills of quantities will be shorter by omitting some of the detail required in the fifth edition.⁽⁹²⁾

*

The sixth edition of the Standard Method of Measurement was introduced during the typing of this research, together with a practice manual.

2.1.6 Development in Tendering Procedure

The established method of selecting a contractor through competition was upheld by the Banwell report, although the application of competition in the form of open tendering was criticized.⁽⁹³⁾ Open tendering takes no account of the contractor's ability to undertake the work, his competence, experience and ability to comply with a programme. It was recommended that invitations to tender should be restricted to a selected number of contractors capable of executing the work to a recognised standard of competence.⁽⁹⁴⁾ Although selective tendering procedures were used by Central Government Departments, Local Authorities had not followed their lead. The report also recommended the wider adoption of serial contracting, two stage tendering, and negotiation.⁽⁹⁵⁾

The Potts⁽⁹⁶⁾ report recommended that greater freedom should be given to authorities to appoint contractors by unorthodox methods, particularly for contracts relating to the Department of Education and Science, the University Grants Committee, Hospital Boards and the Ministry of Housing and Local Government.⁽⁹⁷⁾

In 1975 the Wood⁽⁹⁸⁾ report confirmed that selective tendering was widely used for a high proportion of contracts throughout the industry, and should continue to be used because of its simplicity and ability to secure the best price at the tender stage.⁽⁹⁹⁾ However the report also confirmed that a range of other methods for selecting the contractor were well established.⁽¹⁰⁰⁾ Over the past

decade many⁽¹⁰¹⁾ have written of the developments in tendering and contractor selection, and advocated their wider use.

In a report,⁽¹⁰²⁾ the Building and Civil Engineering Economic Development Committees recognised that the new trends in organisational arrangements had been stimulated by:

- "(i) changing demands on the construction industry to produce more complex projects.
- (ii) efforts to improve integration between design and construction, and to speed project completion.
- (iii) increase in the size of workload for which individual client organisations are responsible.
- (iv) requirements in some cases by overseas clients for a design, construction and operational service as one comprehensive package."⁽¹⁰³⁾

These constraints upon the industry have produced new methods of providing the consultant's role, as in the case of a project manager appointed to supervise both the design and construction teams. Other effects have been the introduction of new methods of selecting the contractor; negotiated contracts; reimbursable contracts; target incentives; two-stage tendering; serial tenders; and continuity tenders.⁽¹⁰⁴⁾ Other new trends have resulted in the contractor providing a different service; design and construct including turn key; develop and construct; and contract management.⁽¹⁰⁵⁾

To satisfy the requirements of the many tendering situations a wide variety of tendering documents are prepared. The trade or work section bill of quantities, the elemental bill, the sectionalised trade bill, the locational bill, the activity bill, the bill of quantities operational format, the notional bill, the bill of approximate quantities, the schedule of rates, drawings and specification.

A clearer definition of public accountability would encourage government officials to use criteria other than the lowest price to appoint contractors.⁽¹⁰⁶⁾

The investigation of how to satisfy the contractor's information requirement continues at government,⁽¹⁰⁷⁾ institutional⁽¹⁰⁸⁾ and individual⁽¹⁰⁹⁾ levels.

2.2 North American Practice

America like England still awards the majority of its building contracts through a process of competition.⁽¹¹⁰⁾ 'Open tendering' has been largely replaced by 'selective tendering'.⁽¹¹¹⁾ Although competition is the rule, and is likely to remain so for the foreseeable future, other methods such as negotiation⁽¹¹²⁾ package deal, design-build or turnkey systems are frequently used.⁽¹¹³⁾

Adrian⁽¹¹⁴⁾ shows that broadly one of two methods are employed for organising the contractual relationships between owners and

constructors, firstly the normal contract, and secondly the separate-but-equal contract.

In the normal contract an owner selects a general contractor, either by competition or negotiation etc., who accepts contractual responsibility for the whole project. The general contractor will complete only part of the work himself and sublet the remainder. It is his responsibility to select and appoint all the sub-contractors and co-ordinate their work. There is no equivalent to the United Kingdom practice which permits some sub-contractors to be nominated by the client in addition. The system produces very strong competition among specialist sub-contractors. However, Heery⁽¹¹⁵⁾ points out that the single-responsibility general contract may not always be feasible or allowable.

As an alternative to the normal contract the owner may choose to employ the contractors himself. Under this arrangement he selects every specialist contractor, either by competition or negotiation, and enters into a separate contract with each one. In addition, the owner may designate one contractor to act as general contractor. In such circumstances the responsibility of the general contractor extends to co-ordinating the work of contractors rather than employing them. The trend of owner/contractor relationships on construction projects is toward the normal contract.⁽¹¹⁶⁾

It is interesting to observe that owner/contractor relationships in England have passed through a similar transition.⁽¹¹⁷⁾

Toward the end of the eighteenth century the owner engaged every master trader under a separate contract. In the first half of the nineteenth century it was common for one such contractor to be designated by the owner to act as main contractor. His function being to co-ordinate the bids and work of other contractors. By the end of the nineteenth century the main contractor was normally appointed with contractual responsibility for the whole project. It is customary today for projects to be awarded to a single contractor, but allowing the architect, as the owner's representative, the opportunity to make nominations to the contractor for the engagement of specific sub-contractors and/or suppliers. It would be exceptional in these cases for the contractor to refuse the nomination, but if he feels justified he may challenge them.

At first sight the technical documentation used for contractor selection, and the measurement process developed by contractors in the United States of America appears to have little in common with the procedures in England. In the Model Form of Instructions to Bidders⁽¹¹⁸⁾ the contract documents are identified as:-

Instructions to Bidders

The Bid Form

The Contract

The General Conditions

The Special Conditions

The Specification

The Drawings

Since no mention is made here of a bill of quantities, one may be influenced by the size of the country, the scale of the economy and the advanced technology, to conclude that a more efficient system had been developed than that currently used in England. Such a conclusion would indeed be hasty. The voice of dissatisfaction is all too frequently raised in their technical publications regarding the excessive size and unsuitability of information in specifications, the problems associated with bidding and evaluating competitive bids based upon specifications, the cost of preparing bids, the problem of valuing variations, the need for basic data to serve design and construction, all of which point to thoughts of change. Regarding the size and content of specifications Durkee writes,

"Job specifications and special provisions are invariably much too thick and unwieldy. This disease of excessive bulk is a strong indication that the documents contain too much unnecessary, conflicting, redundant, and poorly prepared material; and indeed is generally so."

"Even to read through the documents carefully can pose a challenge; and to understand them is often an unattainable goal."⁽¹¹⁹⁾

One may well ask the question, how then can a contractor produce a sensible competitive bid from such information? The bidding period is approximately equal to that given to contractors in England, but with the added responsibility of preparing their own measurements. Boyer and Volkman write,

"The attainment of accurate cost estimates is complicated by the limited time usually provided for preparing a bid and by the fact that the contractor must pay the full expense of preparing the estimate on all jobs, even if he does not receive the contract. In order to conserve time and money many companies rely on estimating techniques which can be inaccurate and unreliable."⁽¹²⁰⁾

Adrian confirms the same point,

"The contractor may not have the time, or be able to allocate the money for a thorough analysis of the documents at the selection decision making stage."⁽¹²¹⁾

It is left to Dunkee to make the last and possibly the most distressing statement on bidding time and specifications,

"Indeed, given the customary time limitations during the bidding stage it is not unusual for bids to be required before all the contract documents are even available."⁽¹²²⁾

Clearly this situation should not be allowed to continue indefinitely. But whether the remedy is the enforcement of discipline on the compiler of documents, or a new form of contract admitting variations is open to question.

One essential activity which the contractor must complete in the preparation of a cost estimate is the measurement of work. Neufville, Heni and Lesage⁽¹²³⁾ discuss the importance of preparing accurate quantities, Boyer and Volkman⁽¹²⁴⁾ allocate an entire section in their paper "Remote Terminal Cost Estimating" to the quantity take-off. Adrian⁽¹²⁵⁾ devotes more than thirteen pages to the subject of "taking-off quantities." It is clear that 'taking-off' is recognised as a vital activity and an essential information source. Adrian states that "taking-off quantities deserves special attention, owing to the vast amount of project information it yields." The process of measuring quantities is sometimes referred to as a quantity survey, and several consultant firms, says Adrian, are in existence who specialize in making quantity surveys.

No direct quantitative link is established between design and construction. Such a link should ideally provide the basis of cost-control and bidding information. Clearly existing specifications do not provide competing contractors with an objective uniform bidding document. The problem is recognised, however, by Warszawski, he recommends following a two stage tender procedure detailed in "The Banwell Report"⁽¹²⁶⁾, awarding the contract through bidding based on a list of representative cost items drawn from the bill of quantities of a similar project.⁽¹²⁷⁾ Such a move might encourage measurement to play a more beneficial role in design and construction.

Byrne,⁽¹²⁸⁾ in what is referred to elsewhere as a 'classic work'⁽¹²⁹⁾ offers a section devoted to finalizing the contract. The first item in the catalogue of common problems hindering the settlement of accounts is 'agreement on final quantities.' It is evident that the design team engage within its own organisation the contractor's counterpart to measure and agree the quantities, and presumably unit rates, for the final account. However, Erikson and Boyer⁽¹³⁰⁾ state in their paper on 'Estimating-State-of-the-Art' that,

"Engineers, architects and other design professionals are in need of good estimating capabilities to facilitate designs within an owner's cost guidelines and to compare possible design alternatives."

Again it is interesting to compare the state of the American industry with England. Higgin and Jessop write,

"In early days (the first half of the nineteenth century) the bill of quantities was thought of as a service to the builder to allow him to arrive at his contract figure It was common practice right into the twentieth century for the architect also to employ a quantity surveyor in parallel with the man employed by the builder."⁽¹³¹⁾

Is it possible that the American industry will follow the twentieth century English development, namely the emergence of an independent professional, advising the design team and the client

on financial matters, cost planning and cost control, tendering procedures, tender evaluation, the preparation of accounts and advising on contractual arrangements? However, the situations, roles and responsibilities are not the same, and only if the trend of the roles is to converge with those experienced in the United Kingdom is it likely to happen.

Writing of the traditional American methods Heery⁽¹³²⁾ shows that too frequently an architect will advance his design by several weeks or even months before introducing an estimator only to find, all too often, he then has to start again.

As a precursor to a new era Heery states, "this age-old and honoured approach is, at best, inefficient." Heery goes on to identify the new professional as the Construction Manager and talks of his role as including; estimating and cost control, scheduling and information systems, time control and expediting, and bid/negotiation/purchasing management.

It appears probable that the day will come when the American design team will prepare within its bidding document a detailed take-off of unit quantities of work. English practice could well play an important part particularly if it is demonstrated how basic data may be structured and manipulated to meet fundamental requirements.

2.3. Canadian Practice

One might well expect the Canadian construction industry to be organised in a very similar, if not identical, manner to that of the United States of America. Although their tendering documentation is considered to be the same, in many other respects the Canadian industry lacks the sophistication, organisation and development of the American industry. Estimating in Canada has been described by Canadians, Americans and English surveyors working in Canada as 'crazy'.⁽¹³³⁾

The majority of tenders are obtained by open invitation,⁽¹³⁴⁾ a process which America and the United Kingdom have tended to pass over in favour of selective tendering.

Any contractor who is able to obtain the surety bonds is qualified to bid. The responsibility of identifying suitable contractors is therefore placed upon the surety companies, rather than the owner or his representative. No standard method exists for measuring building work, nor is there a standard approach to pricing.

Davison⁽¹³⁵⁾ and Walker⁽¹³⁶⁾ both refer to the tendering period as normally being three weeks, irrespective of the contract size. The procedure is that every tenderer will prepare his own take-off for the contract, and produce a quantity schedule which he prices in order to arrive at a total dollar figure for the contract which is his bid.

During this stage the general contractor will advertise in the press announcing his intention to bid for a particular contract and inviting bids from sub-contractors for sections of the work. No limit is placed upon the number of sub-contractors able to tender, providing they are able to secure the necessary bonds, nor are individual sub-contractors restricted to any part or number of work sections for which they may bid. Sub-contractors are likely to submit bids for the same work to several main contractors tendering for the same contract. The system also permits any sub-contractor to revise his bid any number of times by any amount right up until the very minute the general contractor submits his bid.

It is the common practice on the final day of tendering for a representative of the general contractor to locate himself outside the offices of the owner, and maintain an open telephone line to his own head office. The chief estimator will receive and evaluate different sub-contractors' bids right until a few minutes before the final deadline.

The problem facing the estimator when trying to evaluate the sub-contractors' bids is enormous. Bids for the same work will vary from the supply only of the material; supply and placing of material, but excluding finishing e.g. concrete work; finishing only; placing and finishings; or supply placing and finishing. Multiply such a situation by the number of sub-contractors competing for each work section, and then multiply that by the number of work sections, the end result is complicated. But only at the last minute will the

chief estimator make his final decision. Only then with minutes to go will the bid form be filled in and sealed in its envelope and rushed to the owners office. Should the bid arrive late, even one minute, or be sealed in the wrong envelope, or contain an incorrect bond then the bid is void.

Such a system appears prone to error and duplication.

2.4. Australian Practice

Quantity surveying has been practiced in Australia since about 1882.⁽¹³⁷⁾ In 1971 the Institute of Quantity Surveyors (Australia) amalgamated with the Australian Institute of Quantity Surveyors and adopted the latter's title.⁽¹³⁸⁾ As recently as 1976 the resolution was passed at a general meeting of the Institute held at Melbourne that "the Australian Institute of Quantity Surveyors (Victoria Chapter) is in favour of Registration of the quantity surveying profession by a Parliamentary Act."⁽¹³⁹⁾

The role of the quantity surveyor in Australia appears to have changed significantly over the past twenty five years "from a measurer of quantities to a constructive and essential member of the design and construction supervision team."⁽¹⁴⁰⁾ Cashman and Summers⁽¹⁴¹⁾ refer to a rapid expansion of quantity surveying responsibilities. Despite this Kinlay⁽¹⁴²⁾ states "the bill of quantities and its production remains the most time and labour consuming facet of quantity surveying in Australia."

Tenders for contracts particularly in the building industry are based on bills of quantities,⁽¹⁴³⁾ these are said to provide a basis for competitive tendering which is fair and equitable.⁽¹⁴⁴⁾

Several types of bill are used,⁽¹⁴⁵⁾ but clearly the most popular format is the traditional⁽¹⁴⁶⁾ bill of trade format.⁽¹⁴⁷⁾ It is primarily a tender document for the use of builders' estimators and is heavy with narrative and locational information.⁽¹⁴⁸⁾

Before building work is commenced, the successful tenderer must deposit a priced copy of the bill of quantities with the architect.⁽¹⁴⁹⁾ This priced copy then becomes "a contract document for the financial administration of the contract.....
..... it affords the basis of negotiation of certain claims or variations to design."⁽¹⁵⁰⁾ The quantities of work are measured net as fixed in position in the building and are inclusive of effort, organisation and material.⁽¹⁵¹⁾

Although the bill of quantities is not generally accepted as a contract document⁽¹⁵²⁾ Kinlay writes:

"The general adoption of the bill of quantities as part of the contract, as is the case in W.A. (Western Australia), would ensure a more equitable arrangement regarding the contract documents. At present the existing conditions of contract partly recognise the bill in their discrepancy clauses, but only full recognition will ensure equity."⁽¹⁵³⁾

Where the bill of quantities is incorporated fully as a contract document, then it is referred to as a contract bill.⁽¹⁵⁴⁾ In such cases the quantity surveyor will guarantee the quantities.⁽¹⁵⁵⁾ The effect of such guarantee is that the contractor can tender in the confidence that the bill of quantities accurately represents the project as designed.

Bills of quantities are produced in accordance with the Standard Method of Measurement (S.M.M.) This is produced by a joint committee comprised of members of the Australian Institute of Quantity Surveyors and the Master Builders Federation of Australia. The S.M.M. is currently in its third edition (metric), produced in 1971. It caters for the production of a bill of quantities based upon detailed architectural and engineering documentation.⁽¹⁵⁶⁾ It makes no provision for method, sequence, time related charges, nor differs radically from its U.K. traditional counterpart.

However, quoting research conducted at the University of Melbourne into the application of the existing Australian Standard Methods of Measurement, Dr. Dessewffy writes,

"Recent developments in building technology and economics which are influencing the usefulness of the bills of quantities have been discussed in the thesis. It was concluded that, by reason of the considerable changes in the technical and managerial aspects of the construction industry both in Britain and in Australia, bills of quantities in their traditional formats cannot now

be used directly for construction management. For this reason contractors must of necessity remeasure the work, or part of it, for their own management purposes. This is a wasteful, costly and unnecessary duplication of effort."⁽¹⁵⁷⁾

In respect of tendering procedures, tendering documentation, the settlement of accounts and cost control during the design, the British and Australian construction industries are largely similar.

This similarity was assumed by Atkins⁽¹⁵⁸⁾ in his study of The Architects' Right of Variation, in which he took the findings of Australian research⁽¹⁵⁹⁾ as being equally applicable to England.

Similarities of practice in the two countries presumably account for the many advertisements appearing in English journals wishing to recruit English qualified quantity surveyors to Australia.⁽¹⁶⁰⁾ These they evidently secured.⁽¹⁶¹⁾

Because of the similarity between the two countries, Australian articles frequently examine and quote at length procedures, developments, reports and articles produced in England.⁽¹⁶²⁾ Sometimes a whole article is reproduced.

The evidence of the compatibility of the two industries and the cross-fertilization of thinking is left to Dr. Dessewffy:

"Examples of current contractual practices used by the British building and civil engineering industry have been given to illustrate the present-day trends outside Australia."

"Many papers and comprehensive reports on this subject (Contracts) have been published in Australia in recent years and to an even greater extent in Great Britian, and this paper is intended only to supplement all these for the benefit of the Australian industry."⁽¹⁶³⁾

CHAPTER III

METHODOLOGY

C H A P T E R I I I

M E T H O D O L O G Y

The object of the research is to examine the suitability of the information in bills of quantities to meet the varied requirements of the contractor, when used throughout the whole process of tendering and construction.

Essentially the research is composed of two parts, the principal study and the validation study.

The principal study examines in detail the format, adequacy and independence of the information in bills of quantities when used by the contractor during the tendering, pre-contract, construction and final account periods. The principal study then reaches conclusions, based upon expert opinion.

The conclusions reached in the principal study are then tested upon three further samples of opinion in the validation study. These three samples which comprise two groups of specialists and a group of ten quantity surveyors are then examined statistically, firstly to determine whether there is group agreement among the respondents to each question and also examine whether there is disagreement within each group. Secondly, to investigate whether quantity surveyors and specialists agree or disagree significantly between themselves, thirdly, to compare the results of the specialists samples with the conclusions

reached by specialists in the principal study, and finally, calculate an Index of Agreement for quantity surveyors and specialists, and a Measure of Agreement between specialists and the principal study.

3.1. The Sample Frame for the Principal Study

The data used in the principal study was obtained from specialists within one contracting company. Approval to conduct a detailed investigation of the company's organisation and the role which bills of quantities played in the communication process was given by the board of directors. This approval secured the maximum continuity and the greatest commitment of staff to the research during the very long and detailed process of interviewing and data collection, without which the detailed statement of the principal study could not have been made.

The selection of the company to provide the data for the principal study was made upon the following criteria.

(i) Use of traditional tendering methods

The company should secure the majority of its work by traditional tendering methods using bills of quantities. This criterion would ensure that specialisms of procedure and information requirements resulting from package-dealing, negotiation and turn-key methods would be kept to a minimum.

(ii) Representative range of contract values

The range of contract values should be as varied and as wide as possible. The wide range of contract values would ensure that the company had experience of the problems and difficulties associated with tendering, planning, managing and production associated with different sized projects.

(iii) Representative range of clients

The types of client should be wide ranging and representative of the many different clients found within the industry. The wide variety of client would mean that the contractor would be less able to predict the likely response of clients to contractual problems, delays and variations. In such circumstances the contractor would rely more heavily upon the information provided at the tender stage.

(iv) Representative of modern management

The company should be of sufficient size and organisation to use modern management and production methods. Modern management and production methods reflect the development of technology within the construction industry, and will therefore indicate a progressive attitude of mind within the company.

(v) Representative range of non-specialist construction methods

The company should not specialize in particular forms of

construction, methods of erection, or market any specialist building system. This criterion would avoid selecting a contractor who had predetermined and/or standardized methods of construction particular to himself. Such methods would likely generate their own special information requirements and therefore could not be regarded as representative.

Company Selection

Based on the foregoing criteria an international construction company that obtained the majority of its work by traditional tendering methods was approached and asked to provide the data for the principal study. The company undertook contracts ranging in value from a few thousand pounds to multi-millions, there was no upper or lower limit on contract values for which it was prepared to tender. Its clients varied from national and local authorities, large corporations and industrial concerns to private individuals. On average the company submitted a tender every day of the year which involved it in using every type, size and variety of bills of quantities.

It was explained that a lengthy process of interviewing would be involved and data, i.e. opinions of staff, would be recorded. The company agreed to assist and provided every facility and service that was asked of it.

The research is entirely concerned with the judgement of estimators, planners, buyers, agents, contract managers and surveyors as their total experience led them to answer, rather than wishing to record the opinion of one company.

The number of specialists interviewed varied from two to five for each task. The criteria used to establish consensus between the respondents was a dichotomous selection of options relating to the three aspects of information utility, format, adequacy and independence. Each information package was judged by the individual respondents to be either adequate or inadequate, suitable or unsuitable in format, independent or dependent upon other information sources. On every occasion the respondents were found to agree and consequently it was unnecessary to record the individual responses.

It may appear that a single company is unrepresentative of the population of construction companies. However, it can be argued that large companies, such as the one sampled, are themselves microcosms of the construction industry as a whole and thus are in many respects very representative of the entire industry.

This unanimity was thought to be unusual since one might expect some difference of opinion. However, the measure of agreement between the respondents in the principal study can be verified in the validation study, by calculating the Measure of Agreement between specialists within the validation study.

The variation between respondents in the principal study and the validation study may be represented as follows:

Total variation between		Variation between		Variation
experts over different	=	experts within	+	between
companies		one company		companies

and since variations (e.g. in terms of statistical variances) are positive it follows that over all companies and experts:

Variation between
experts within
one company \leq Variation between
experts over
different companies

or that the:

Index of Agreement
between experts
within one company \geq Index of Agreement
between experts
over different companies

But as is shown in section 5.4.2. the Index of Agreement between all the specialists on the validation study is 94.5%. Knowing that this extremely strong consensus exists across companies it is then not too surprising that in the principal study one encountered a unanimous agreement across the specialists within the selected company.

3.2. Evaluation of Bills of Quantities

It is normal practice, within the building industry, to prepare a bill of quantities in accordance with the Standard Method of Measurement of Building Works⁽¹⁶⁴⁾ for all contracts in excess of £10,000 in value when competitive tenders are required by the client. The Joint Working Party on Measurement Conventions⁽¹⁶⁵⁾ stated in its report that a bill of quantities should not only afford a quick

appreciation of the general complexity, value and scope of the works, but should also be capable of being priced accurately and cheaply.

The bill of quantities broadly contains four areas of information, preliminaries, preambles, measured work and prime cost and provisional sums. Although these areas of information are readily identifiable, they are not necessarily arranged separately. The arrangement and positioning of the information is governed by the type of bill being produced.

Preliminaries consist of all matters which have an effect upon the contract sum, but do not form part of the finished works. They are not concerned with the quality or standards of materials or workmanship.⁽¹⁶⁶⁾ It is common practice in all types of bills of quantities, to present the preliminary information within a self-contained section.

Trade preambles commonly refer to British Standards, Codes of Practice, manufacturers' catalogues, and specification notes, and are thus descriptive. They identify the type and quality of material to be used, the standards of workmanship to be achieved, the degree of protection for work (where applicable), the samples to be submitted for approval, and the frequency and standard of all tests on materials or structure which may be required throughout the duration of the contract.

The measured work section consists of a detailed tabulation of items, collectively representing the work to be constructed. Each item has two parts, the detailed description of the work, and the

quantity. Also space is provided in this section of the bill for the estimator to enter his prices. The parameters controlling the provision of information within this section are covered in detail by the Standard Method of Measurement of Building Works. The Standard Method of Measurement identifies measurable items of work, the units of measurement, the classification stages into which the measurement must be grouped, and the information elements deemed essential for a full and composite description of the work. This section is the largest of the four information groups.

The information contained within the prime cost and provisional sum section relates to estimated sums for sections of construction work which may be expended in respect of nominated sub-contractors' work, nominated suppliers' materials, a local authority service, or work undertaken by the main contractor.⁽¹⁶⁷⁾ Work is included as a prime cost or provisional sum item when the design is incomplete, or the nature, or extent of the work is uncertain at the time of tendering.

Bills of quantities of many different formats were examined in order to identify fundamental items of information. The items obtained were then sorted into the sections of preliminaries, preambles, measured work and prime cost and provisional sums. The items of information were then grouped, for convenience of handling under a number of appropriate headings. These headings, or information packages as they are referred to in the research, are as follows:

1. Project Details
2. Site and Location
3. Form of Contract
4. Times and Phasing
5. Financial Details
6. Statutory Details
7. Facilities and Services
8. General Responsibilities
9. Material Specification
10. Workmanship
11. Handling and Placing Material
12. Tests and Samples
13. Locational Details
14. Work Quantities
15. Quantity Units
16. Unit Rates
17. Rate Extensions
18. Extension Totals
19. Work Descriptions
20. Description Dimensions
21. Provisional Quantities
22. Temporary Works
23. Demolitions
24. P.C. Sums-Nominated Sub-Contractors
25. P.C. Sums-Nominated Suppliers
26. Provisional Sums
27. Contingency

The definitions of these information packages, used in this research, are contained in Appendix A.

These information packages form the core of the enquiry by testing, through expert opinion, the suitability of format, adequacy and independence of the information when used for different purposes.

3.3 Format, Adequacy and Independence

The research does not present the factors of format, adequacy and independence as independent variables but recognises that they are co-variant. However, the three factors could be clearly understood and separately identified by the judges.

- (i) Format: refers to the presentation, structure and arrangement of information as it appears in the bill of quantities.
- (ii) Adequacy: refers to the absence of any necessity to make additional allowances, alterations or amendments before making use of the information presented in the bill.
- (iii) Independence: refers to the absence of any need to seek additional information to supplement that presented in the bill.

In introducing these to contributors the distinction was made by reference to a hypothetical situation. A husband pays the housekeeping, ten pounds, on Saturday morning by cheque. It may be perfectly adequate, but in an unsuitable format. Conversely the housekeeping is paid in ten one pound notes. The format is satisfactory but the ten pounds may be totally inadequate. The cheque is dependent upon the support and service of the bank staff but the pound notes on the other hand are independent since they are readily useable.

It was in these terms that the judges declared information packages satisfactory or not.

3.4 Structure of Data Analysis

The more obvious approach of structuring the analysis by company departments was rejected, since such a method would introduce into the results factors of departmental size, company structure, personal responsibility and job specification, all of which not only vary considerably from one company to another, but lack consistency of interpretation across the industry.

The development of an improved standardised structure for project information was considered in the report, "An Information System of the Construction Industry,"⁽¹⁶⁸⁾ to be one of the highest priorities of data co-ordination, affecting both the communication of information and its preparation and rationalisation. Also

included in the broad concept of standardisation of project information for the construction industry was the preparation, cross-referencing and presentation of bills of quantities. It was therefore considered desirable to develop a structure for the analysis of data in this research.

The system of functions, procedures and tasks used in the study of "Coding and Data Co-ordination for the Construction Industry"⁽¹⁶⁹⁾ was considered not only fundamental to the construction industry at large, but it was also eminently well suited to this research as a basis for analysis. The study defines the functions, into which this research falls, as "the planning of work, including financial budgetting and control, and the allocation, acquisition and development of resources on site to achieve the completion of the project."⁽¹⁷⁰⁾ Each function is composed of a number of procedures, and each procedure is in turn composed of a number of tasks. Procedures were considered as "formalized ways of executing tasks having identifiable end points."⁽¹⁷¹⁾ Tasks were defined as basic activities which collectively compose a procedure.

The report "Structuring Project Information,"⁽¹⁷²⁾ a subsidiary study for the National Consultative Council's Working Party on Data Co-ordination, studied the arrangement and presentation of information for building projects. The concept of functions, procedures and tasks developed in the main data co-ordination study was also used in this report as a basis for structuring the analysis of results. Although the report was necessarily concerned with the

total range of information and documentation used by the contractor during the construction period of the building process, the structure of contractor's procedures, shown in Figure 1, offered itself as a sufficiently detailed basis for the analysis of data in this research.

The definitions of these procedures for the purpose of this research are contained in Appendix B. These definitions are based upon the report 'Structuring Project Information'.⁽¹⁷³⁾

By a process of interview and discussion the schedule of contractor's procedures was subdivided into those which used the bill of quantities and those which did not. Figure 2 shows those procedures which use the bill.

3.5 Identifying Tasks

Tasks are defined as basic activities which collectively compose a procedure. The criteria considered essential for the identification of tasks was firstly, that every activity must subjectively be considered approximately equal in importance, and secondly, each task must be a separately identifiable activity.

Through a process of repeated interviews and discussion with experienced judges, every separately identifiable activity, or task, was listed for all the procedures using the bill of quantities.

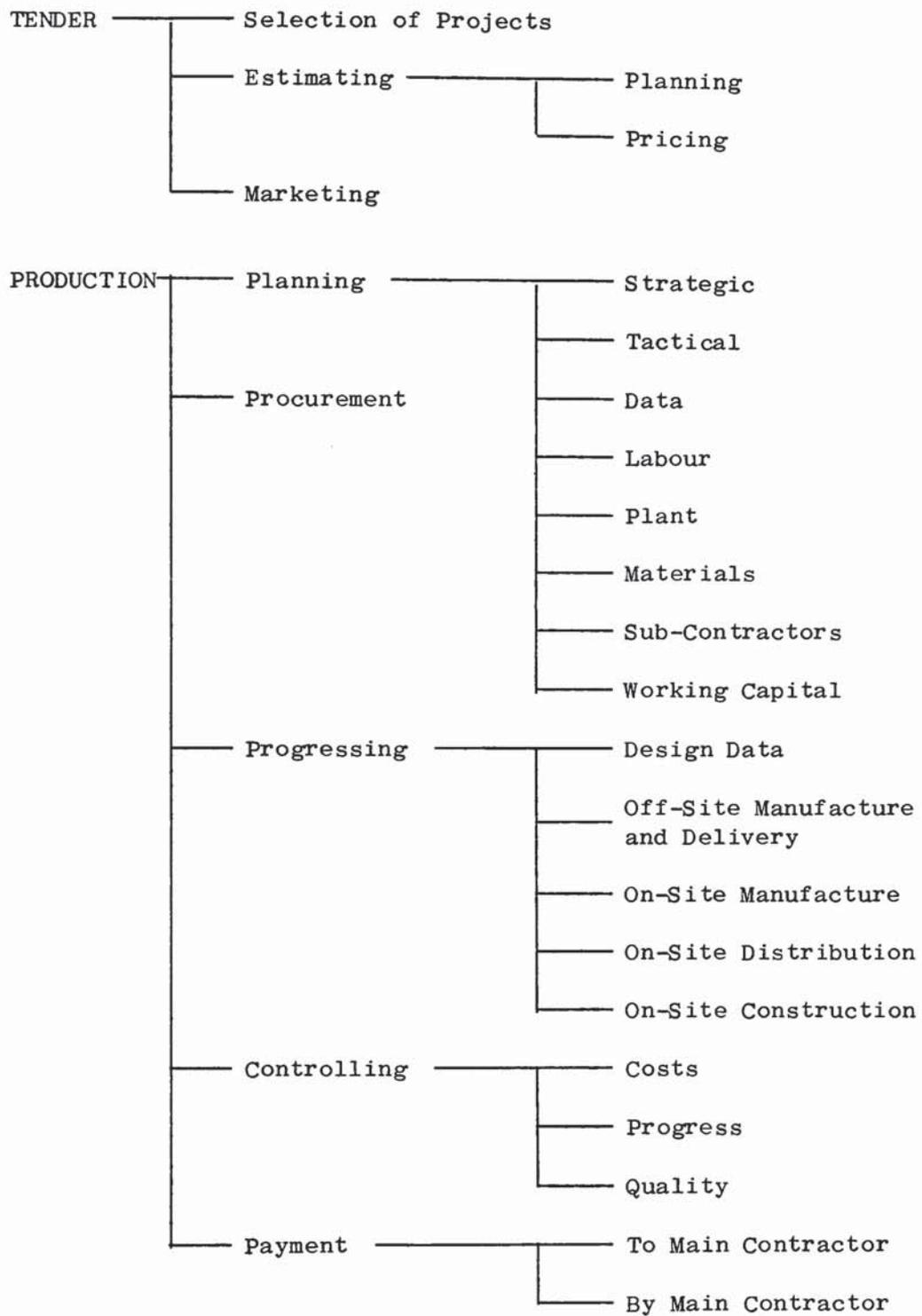


FIGURE 1

CONTRACTOR'S PROCEDURES

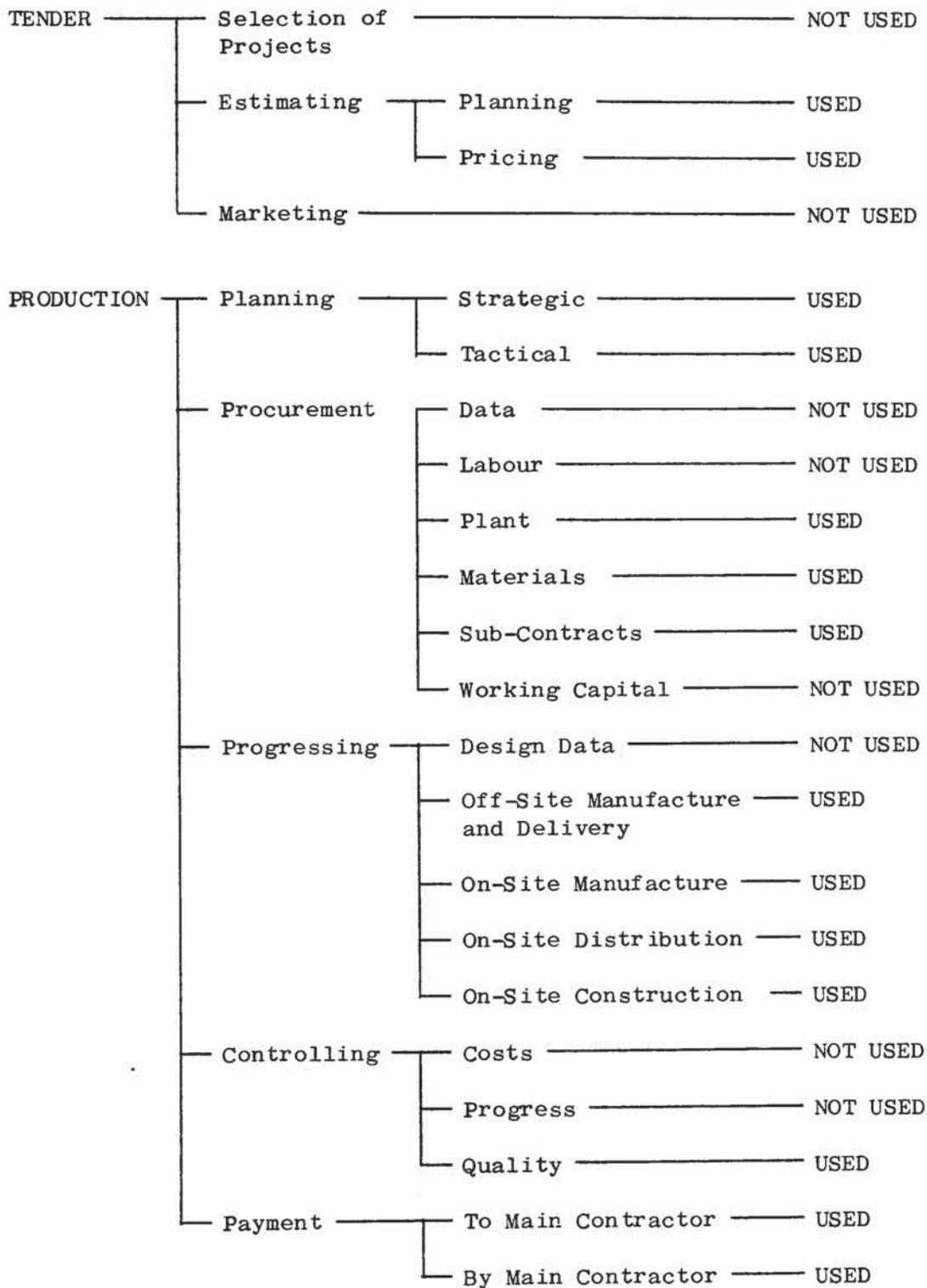


FIGURE 2

CONTRACTOR'S PROCEDURES WHICH USE THE
BILL OF QUANTITIES

At this stage two amendments were made to the schedule of contractor's procedures where the bill of quantities was used. Firstly, the procedure Production Procurement Sub-Contracts was sub-divided into two procedures, Procurement Domestic Sub-Contractors and Procurement Nominated Sub-Contractors and Suppliers. The reason being that the information requirement of the two areas were quite different and the method of employment a totally different process. Secondly, the procedure Production Progressing On-Site Construction, although identified as using the bill of quantities, was withdrawn from the list of contractor's procedures for consideration in this research since no accurate subjective assessment of the bills use could be made.

The final list of contractor's procedures for examination and sub-division into tasks is shown in Figure 3.

Again by interview, discussion and a close consideration of the information requirement of each individual task, the tasks were subdivided into users and non-users of the bill of quantities.

The list of tasks identified as using information from the bill of quantities is given in Appendix C.

T E N D E R	
1.	Estimating Planning
2.	Estimating Pricing
P R O D U C T I O N	
3.	Planning Strategic
4.	Planning Tactical
5.	Procurement of Plant
6.	Procurement of Materials
7.	Procurement Domestic Sub-Contractors
8.	Procurement Nominated Sub-Contractors and Suppliers
9.	Progressing Off-Site Manufacture and Delivery
10.	Progressing On-Site Manufacture
11.	Progressing On-Site Distribution
12.	Controlling Quality
13.	Payment to Main Contractor
14.	Payment by Main Contractor

FIGURE 3
SELECTED CONTRACTOR'S PROCEDURES

3.6. Basic Data

Again by interview, the estimators, planners, buyers, agents, contract managers and surveyors, firstly identified the specific information packages from the bill of quantities which were used to complete each task.

Secondly, the information packages used in each task were then examined individually, to ascertain whether the format of the information was suitable or unsuitable having regard to the work within the task; whether the information was adequate or not as presented and whether the specific information being used from the bill of quantities could, without supplementary reference, satisfy the particular need.

The data collected is discussed in detail in Chapter IV.

3.7. Programming Tasks in Time Sequence

The data collected thus far permitted the inspection and discussion of the format, adequacy and independence of the bill of quantities as it is used in relation to every task and every procedure. However tasks are identifiable parts of the whole construction activity which must be executed in a correct and timely sequence if the primary objective of building is to be

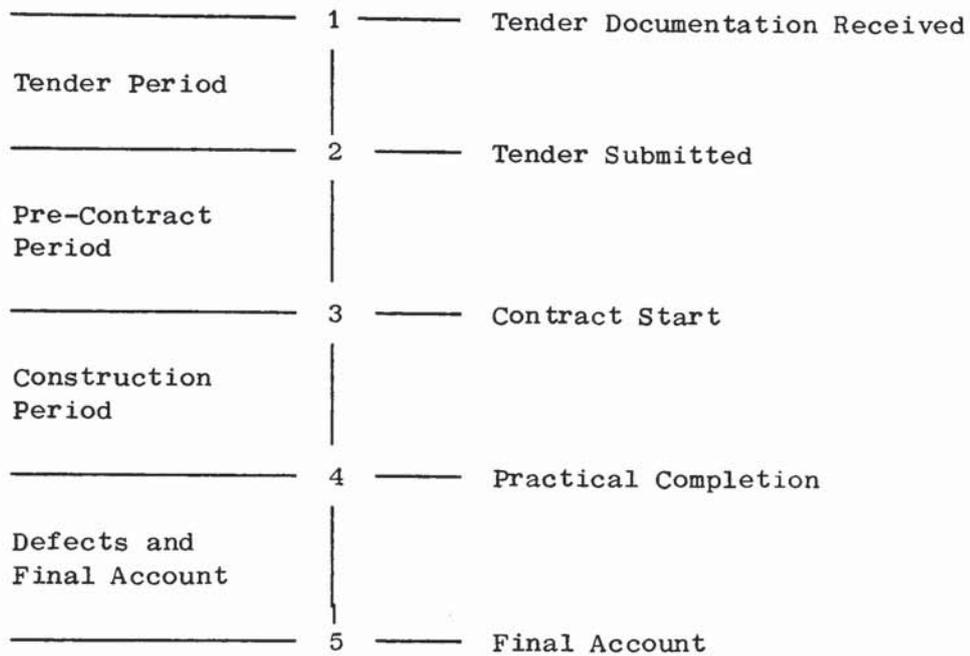


FIGURE 4
PROJECT TIMES

achieved.

The tasks, which collectively represent the work to be undertaken in any contract, vary in duration from one contract to another according to the nature of the construction, the general complexity of the work, the number of nominations and the contract period. It was not possible therefore to establish, in general terms, any specific period of time for the duration of each task, but rather to establish the starting and finishing point of each task in relationship to all other tasks and their relationship to the five significant project times, see Figure 4. Judges of

expert opinion were asked to programme the tasks within the context of the five significant project times and having regard to the starting and finishing points of all other tasks.

As the programme of tasks related to the time sequence developed each person being interviewed was invited to re-examine and amend, if appropriate, any earlier assessment as considered necessary, having regard to the overall judgement. The final development of the integration of procedures and tasks arranged in the concept of time is shown in Figures 5 and 6.

The programme of procedures and tasks, Figures 5 and 6, also show thirty changes, where either a new task is introduced, or a task ends. These thirty change points, marked a to ad in Figures 5 and 6, permit a vertical inspection across procedures of the format, adequacy and independence of the data in the bill of quantities. These thirty totals provide a framework for examining the format, adequacy and independence of the bill of quantities throughout the whole period of time, from tender to final account. They also accommodate the inspection of procedures or groups of procedures, e.g. strategic and tactical planning, as they relate to time.

The whole of this data and the programme of procedures and tasks integrated in a time sequence are discussed in Chapter IV.

3.8 The Validation Study

The purpose of the validation study is to test the conclusions reached in the principal study upon a larger sample of expert opinion in order to ascertain whether these conclusions are generally supported across the industry.

3.8.1 The Sample Frame For the Validation Study

Three samples of data were collected for the validation study, two from specialists and the other from a group of ten quantity surveyors. Although the process of validating the principal study must really be left to the specialists, it was also considered important to discover whether any significant difference of opinion exists between specialists and quantity surveyors.

For each question posed in the validation study there were responses from two groups of specialists and responses from the group of ten quantity surveyors, each representing a number of different construction companies. Although it is the opinion of specialists that is sought rather than the opinion of a company, it was considered essential to obtain these opinions for the validation study from a range of companies.

The principal aim for selecting these companies, from which opinion should be sought, is that the sample should be representative of the group of companies to which it is wished to extend the conclusions.

The selection of the companies to provide the data for the validation study was made upon the following basic criteria:

Use of traditional tendering methods

All the companies selected should obtain the majority of their work by traditional tendering methods. As in the principal study, this criterion would keep the influence of specialisms resulting from non-traditional tendering methods to a minimum.

Within this, the general approach is to ensure representation by stratifying companies, taking account of criteria which will influence the total amount of information generated and used within a company, such as company size, range of work, the organisation and sophistication of procedures and management, and then, selecting samples from each strata.

The stratification is relevant with respect to:

- (i) International companies
- (ii) National companies
- (iii) Regional companies

However, with respect to other criteria such as type of client, and contract values, by selection, it is possible to cover the various strata within a given company.

Within each stratum the following criteria for selection were applied:

(i) Representative range of contract values

The range of contract values should be as varied and as wide as possible. This would ensure that companies were widely experienced in the problems and difficulties associated with contracts of different size and type. Clearly there would be coverage of various strata if all companies selected undertook a wide range of contracts.

(ii) Representative range of clients

The types of client for which each company worked should be as varied as possible. Again, there would be coverage of different strata since companies of different size are likely, at different times, to undertake work for the same or similar clients, particularly where a client has a large and varied building programme.

(iii) Representative range of management methods

The organisation and management of the companies should be representative of other companies within the strata.

(iv) Representative range of non-specialist construction methods

The companies should not specialize in particular forms of construction, methods of erection, or market any specialist building system.

The contracting companies from which the first sample of specialists' and quantity surveyors' opinions was obtained were chosen from the population of contracting companies in the Midlands area. A representative selection was made within each stratum. The very fact of personal selection, however informed, does leave the process open to the criticism that unconscious bias may have been introduced.

In order to check whether or not bias had been introduced a further sample of specialists' opinions was taken within the strata by a randomised procedure as follows:

1. The sample was drawn from the population of construction companies in England registered with the National Federation of Building Trades Employers.
2. The country was divided into three areas, North, South and Midlands, to ensure a wide geographical response.
3. One N.F.B.T.E. Regional Handbook was selected randomly to represent each of the three geographical areas.
4. Construction companies were selected randomly to represent each area, first, by drawing a number, from a box of prepared numbers, to represent a page in the handbook, and secondly, drawing a further number to represent the entry on the page. An equal number of companies were chosen to represent each of the three areas.

Companies which were unrepresentative were rejected and further random selections made. Not all of the suitable companies first selected were willing to participate in the research, and in such circumstances further companies were chosen by the same random method.

The Measure of Agreement between specialists of the first sample and the principal study, discussed in Section 5.4.2, is 97.8%, with a 'single sided' 95% confidence interval of [94.9%, 100%]. The Measure of Agreement between specialists of the second sample and the principal study falls well within this interval at 96.23%. The second study confirms the first study and therefore there is no evidence of bias.

3.8.2 Procedure of Validation

The validation process is composed of four parts:

1. An examination of the questionnaire and the specialists' responses in samples B and C to ascertain whether or not the data collected was influenced in any marked way by the phrasing of the questions.
2. An analysis of samples A and B, the groups of quantity surveyors and specialists, to examine whether there is agreement or disagreement between groups of respondents within each group.
3. To compare the group response of quantity surveyors, sample A, with that of specialists, sample B, for each question.

4. To ascertain whether the validation data provided by the two samples of specialists supports or refutes the observations of specialists in the principal study. Also to ascertain an Index of Agreement within samples and a Measure of Agreement between samples and the principal study.

CHAPTER IV

THE PRINCIPAL STUDY

C H A P T E R I V

THE PRINCIPAL STUDY

4.1. Tendering

4.1.1. The Suitability of the Format

During the fifty six years of experience since the publication of the first edition of the Standard Method of Measurement, the building industry has developed the existing system of measurement and documentation, in the form of bills of quantities, in order that, at the time of tendering, all contractors might make their offer on the same factual basis.

The apparent objective of such a bill of quantities is to define in terms of quantity and specification precisely what is expected from the contractor by the client and to present this model in such a manner as to facilitate a ready appreciation of the work involved and permit the contractor to forecast accurately what the work will cost. There must be some shortfall in performance if for no other reason that language itself does not always convey a precise and unambiguous meaning. Indeed, if different and additional objectives exist then there may also be losses due to compromise. The bill establishes what must be provided in order to receive agreed payment. For this reason the bill of quantities is regarded by the building industry as the major financial control document.

The perceived suitability of the format of individual areas of information, used from the bill of quantities for the planning and pricing functions of tendering are shown in Figure 7.

On inspection it is clear that all the information provided in the bill is well used in the tendering process, and that most of it is presented in a format which is seen to be suitable for tendering purposes. It is, however, also evident that certain areas of information are not presented in a manner capable of satisfying all the demands of tender planning and tender pricing. Such inadequacies constitute a shortfall in the realization of the objectives of the bill.

Figure 7 shows that the whole of the preliminary section of the bill, packages 1 to 8, is presented in a format considered suitable for tendering. The content of the preliminary information is also seen to be totally adequate for tender planning and substantially adequate for tender pricing, Figure 8.

Similarly the trade preambles are regarded as being suitably presented and adequate both for tender planning and pricing. However, the preamble item of handling materials and components is an exception. This information appears to be unsuitable in format when used for pricing any project and establishment overheads, and is also seen to be inadequate when used to plan and price the labour, plant, domestic sub-contractors and project overheads. The subject encroaches on method. This may be seen to be a matter for the contractor who undertakes his own research and investigation.

○ = Suitable Format
 x = Unsuitable Format

	Tender Planning						Tender Pricing							
	Package No.	Materials and Nominated Suppliers	Labour	Plant	Nominated Sub-Contractors	Domestic Sub-Contractors	Project Overheads	Materials and Nominated Suppliers	Labour	Plant	Nominated Sub-Contractors	Domestic Sub-Contractors	Project Overheads	Establishment Overheads
Project Details	1		○	○		○	○		○		○	○	○	
Site and Location	2	○	○	○		○	○	○	○		○	○	○	○
Form of Contract	3				○	○					○	○	○	○
Times and Phasing	4	○	○	○	○	○	○	○	○	○	○	○	○	○
Financial Details	5													
Statutory Details	6	○	○	○	○	○	○	○	○	○	○	○	○	○
Facilities and Services	7	○	○	○	○	○	○	○	○	○	○	○	○	○
General Responsibilities	8	○	○	○	○	○	○	○	○	○	○	○	○	○
Material Specification	9	○	○	○		○								○
Workmanship	10		○	○		○					○			○
Handling	11		○	○		○	○				○	x	x	
Tests and Samples	12	○				○					○			○
Locational Information	13		○	○	○	○				○				
Quantities	14	x	x	x		x	x				○	○	○	
Quantity Units	15	x	x	x		x	x				○	○	○	
Rates	16													
Extensions	17													
Totals	18	○											○	○
Descriptions	19	○	○	○	○	○	○							
Description Dimensions	20	○	○	○	○	○	○							
Provisional Quantities	21	x	x	x		x	x				○			
Temporary Work	22	○	○	○		○	○				○			
Demolition	23	○	○	○		○	○				○			
Nominated Suppliers	24	○											○	○
Nominated Sub-Contractors	25	x	x	x	x					x			○	○
Provisional Sums	26												○	○
Contingency	27												○	○

FIGURE 7

SUITABILITY OF FORMAT FOR TENDERING

Consideration should be given perhaps to a form of description which does not encroach on method but affords an equitable basis for tendering. It affords a problem which is not easily solved as the site layout of construction equipment, accommodation and process (its basis) is a matter for the contractor's discretion.

The measured work section of the bill contains the largest amount of information. It is in this section of the bill that the contractor inserts the unit rates to be charged for work done.

It is significant to observe that all the information provided in the measured work section of the bill is seen to be presented in a suitable format for the tasks of pricing. Indeed since this is the function which the document is designed to serve one would be greatly perturbed if a lesser observation were made.

However the format of the measured work section is not as suitable for tender planning. The quantities and provisional quantities used when planning materials, labour, plant, domestic sub-contractors and project overheads are found to be unsuitable in format for all of them. Clearly a different set of criteria must be considered for the presentation of quantity information if the requirements of tender planning are to be met.

The quantities are the essence of the bill. In addition to their unsuitability for tender planning Figure 9 shows that the quantities are seen to be inadequate for pricing and planning.

Although the format of the units of measurement are considered suitable for pricing, the same units of measurement are seen to be inadequate, Figure 9. If for the purposes of gaining quotations and for direct pricing, and gaining payment for work done, there is a preference for units of measurement relating to work in place, then consideration might be given to its supplementation.

It is understandable that the quantities should be considered inadequate for tender planning because process is not considered, and planning is about process. If method is a component of contractor competitiveness, then the full benefit of such a form of documentation is perhaps not being realized. Perhaps again a supplement to the quantities for pricing purposes might also satisfy some of the inadequacies of the quantities for planning purposes.

The descriptions of work, which are used by all the tasks of planning and five of the pricing tasks are seen to be both suitable in format and adequate. This fact assumes a greater significance when considered with the fact that the quantities are suitably presented for pricing purposes, since together they support the distinctive concept of measuring and describing the unit of work as fixed in position which is characteristic of the systems used in the United Kingdom.

The only other areas of information which are seen to be unsuitable in format for tendering purposes are packages 25 and 26, nominated sub-contractors and provisional sums. The nominated sub-contractor's information is used by five of the six planning tasks, but is unsuitable in format for any one of them, as well as being

poorly regarded for pricing the nominated sub-contractor's items. This section of the bill can account for anything up to 50% of the contract sum, therefore the fact that the format of the information is seen to be unsuitable is more important than may at first be evident.

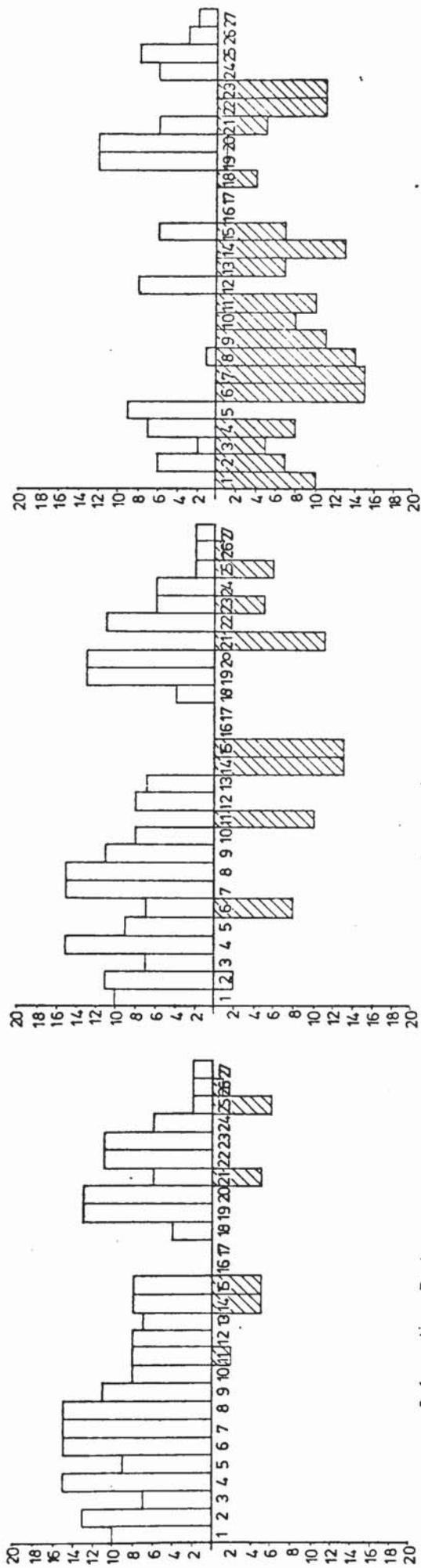
Figure 9 shows that these packages of information also appear to be inadequate for pricing and planning the materials, labour, plant, nominated sub-contractors' work and project overheads.

If the practice of including such large prime cost sums in the bill of quantities is to continue, then the format of the items should perhaps identify those factors which are significant to the contractor's costs. The fact that the current information is used to plan the engagement, distribution and attendance upon sub-contractors and suppliers suggests that any inadequacy places difficulties in the path of an estimator seeking to provide for the main contractor's costs associated with them.

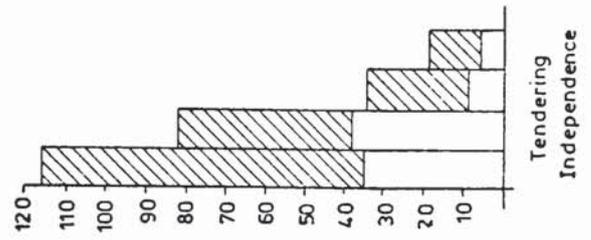
Considering the care and attention given to the preparation of the remainder of the bill, it seems odd that an increasingly cost significant area should be prepared in such an inadequate manner. If the inadequacy of the information is considered concurrently with the problems of format, it emerges that the information is seen to be in need of some restructuring and amplification.

Figure 8 shows the summary of information packages used in tendering. The four totals shown in 'tendering format' correspond to the four change points a,b,c and d, on the programme of integrated

Vertical Scales = Number of Recorded Uses.

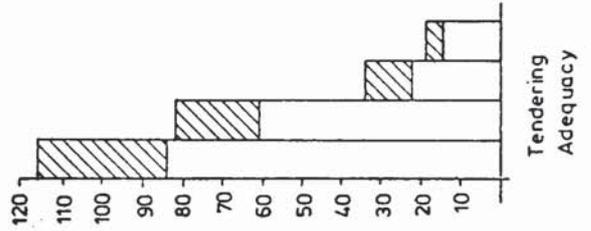


Information Packages



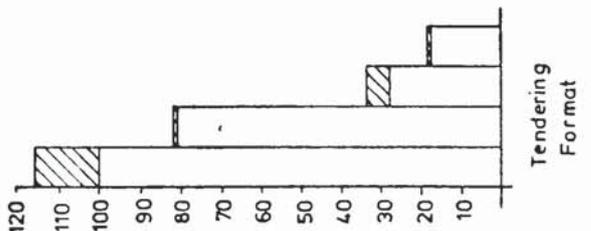
Tendering Independence

Information Packages



Tendering Adequacy

Information Packages



Tendering Format

FIGURE 8
TENDERING - FORMAT, ADEQUACY AND INDEPENDENCE

tasks in time order given in Figure 5 of Chapter III. Figure 8 shows the changing pattern of use of the bill during the tendering period, and how frequently the usefulness of individual areas of information is recognized. The hatched areas of Figure 8 indicate cases where information is used but is seen to be unsuitable.

Having regard to the overall picture of format related to the total use made of the individual packages during tendering, it is clear that packages 25, nominated sub-contractors, has both the largest number of unsuitable uses, and the highest proportion of unsuitability.

4.1.2. The Adequacy of Information

The adequacy of the information provided in the bill of quantities should be of prime concern to those having contractual responsibility to convey the clients requirements to the contractor. It is unlikely that this single document will satisfy all the demands which the contractor may make upon it, never-the-less careful thought should be given to providing information whose content satisfies the requirement of competing tenderers, that it should be interpreted in the same manner by them all.

The adequacy of the information provided in the bill of quantities as it is regarded by those preparing the tender is shown in Figure 9.

○ = Information Adequate
 × = Information Inadequate

	Tender Planning						Tender Pricing						
	Package No	Materials and Nominated Suppliers	Labour	Plant	Nominated Sub-Contractors	Domestic Sub-Contractors	Project Overheads	Establishment Overheads	Domestic Sub-Contractors	Nominated Sub-Contractors	Plant	Labour	Materials and Nominated Suppliers
Project Details	1		○	○		○	○					○	○
Site and Location	2	○	○	○		○	○					○	○
Form of Contract	3				○	○							○
Times and Phasing	4	○	○	○	○	○	○					○	○
Financial Details	5											○	○
Statutory Details	6	○	○	○	○	○	○					○	○
Facilities and Services	7	○	○	○	○	○	○					○	○
General Responsibilities	8	○	○	○	○	○	○					○	○
Material Specification	9	○	○	○		○						○	○
Workmanship	10		○	○		○						○	○
Handling	11		×	×		×	×					○	○
Tests and Samples	12	○				○						○	○
Locational Information	13		○	○	○	○						○	○
Quantities	14	×	×	×		×	×					○	○
Quantity Units	15	×	×	×		×	×					○	○
Rates	16												
Extensions	17												
Totals	18	○											○
Descriptions	19	○	○	○	○	○	○						
Description Dimensions	20	○	○	○	○	○	○						
Provisional Quantities	21	×	×	×		×	×						
Temporary Work	22	○	○	○		○	○						
Demolition	23	×	×	×		×	×						
Nominated Suppliers	24	○											○
Nominated Sub-Contractors	25	×	×	×	×				×				○
Provisional Sums	26												○
Contingency	27												○

FIGURE 9

ADEQUACY OF INFORMATION FOR TENDERING

To avoid repetition where information is seen to be inadequate as well as being unsuitable in format, the inadequacy has already been discussed under the heading of format.

Although the preliminaries are generally adequate for tendering, two specific areas of information appear to be inadequate for pricing purposes, firstly, the details describing the site and its location (package 2), and secondly, the statutory details (package 6). Both, very reasonably, might be seen to need that information which is to be gained from a site visit and enquiry at the offices of the designer and of the local authority concerned.

Although the information describing the site and its location is seen to be adequate for pricing the materials, the labour, the plant and domestic sub-contractors, more detail is required to price the project and establishment overheads. Clearly the onus to visit and inspect the site during the tender stage remains with the contractor. Whether, however, a bill which does not draw attention to critical information which might be obtained by inspection of the site and its location, can be said to afford an equitable factual basis for all tenderers is perhaps open to question.

The statutory details provided in the bill, although considered adequate for tender planning purposes are seen to be quite inadequate for pricing. The information lacks the detail necessary to price the responsibility associated with the statutory obligations. The detail is often provided to the competing contractors by the local authorities and statutory bodies. If the

information has cost significance, and is readily available, then the contractor's requirement should perhaps be catered for in the bill.

One further area of inadequacy not previously discussed in conjunction with problems of format is that of demolition work (package 23). The details describing demolition work are shown in Figure 9 to be adequate for tender pricing but inadequate for tender planning. This is a reversal of the situation existing with package 2, site and location, where the information was adequate for planning but inadequate for pricing.

One reason for this reversal may be that the contractor selects a method of assembly which best suits him, while here he is obliged to give careful regard to the building and possibly follow a sequence which the structure dictates in demolition. Therefore in the case of demolition work described in the bill of quantities, the information may well be adequate for pricing purposes, since it states what has to be removed, but still be inadequate for planning since it is again, by convention, required to avoid direction as to method.

The tender adequacy diagram, contained in Figure 8, shows the summary of the adequacy and inadequacy of information. In total eight of the twenty seven information packages have inadequacies, and four of these eight, namely handling materials and components, the quantities, the quantity units and the provisional quantities are seen to be totally inadequate.

4.1.3. The Independence of Information

Figure 10 shows the information which is used from the bill of quantities for tendering and whether it is dependent or independent of support from additional information. It is evident that most information is dependent upon the support of other data. However, there are areas where the information is self sufficient for part or even the whole of its use.

Additional data can be of a number of types, but falls into two principal categories. That which is obtained by direct reference to standards or catalogue number which, given at length, would unduly extend descriptions, but which in its cryptic form is equally available and understandable to all tenderers. There is also that which is derived from the records and practices of the firm and forms an element of its competitiveness. Lack of independence is not necessarily then a criticism of the bill.

In the preliminaries section of the bill, package 5, financial details, is an area of information which is well catered for. The information is quite independent of other data as well as being in the correct format and totally adequate.

Packages 2 and 4, site and location and times and phasing, are both independent as sources of information when used for pricing the materials, labour, plant and domestic sub-contractors, but are dependent upon other information to complete the tasks of tender planning.

○ = Information Independent
 x = Information Dependent

	Tender Planning						Tender Pricing							
	Package No.	Materials and Nominated Suppliers	Labour	Plant	Nominated Sub-Contractors	Domestic Sub-Contractors	Project Overheads	Establishment Overheads	Project Overheads	Domestic Sub-Contractors	Nominated Sub-Contractors	Plant	Labour	Materials and Nominated Suppliers
Project Details	1		x	x		x	x			x			x	x
Site and Location	2	x	x	x		x	x			x			○	○
Form of Contract	3				x	x								
Times and Phasing	4	x	x	x	x	x	x						○	○
Financial Details	5													
Statutory Details	6	x	x	x	x	x	x						x	x
Facilities and Services	7	x	x	x	x	x	x						x	x
General Responsibilities	8	x	x	x	x	x	○						x	x
Material Specification	9	x	x	x		x							x	x
Workmanship	10		x	x		x							x	x
Handling	11		x	x		x	x						x	x
Tests and Samples	12	○				○							○	○
Locational Information	13		x	x	x	x							x	x
Quantities	14	x	x	x		x	x						x	x
Quantity Units	15	x	x	x		x	x						○	○
Rates	16													
Extensions	17													
Totals	18	x					x							x
Descriptions	19	○	○	○	○	○	x						○	○
Description Dimensions	20	○	○	○	○	○	x						○	○
Provisional Quantities	21	x	x	x		x	x						○	○
Temporary Work	22	x	x	x		x	x						x	x
Demolition	23	x	x	x		x	x						x	x
Nominated Suppliers	24	○					○							○
Nominated Sub-Contractors	25	○	○	○	○		○							○
Provisional Sums	26						○							○
Contingency	27													○

FIGURE 10

INDEPENDENCE OF INFORMATION USED FOR TENDERING

The measured work section forms the heart of the bill of quantities, and its substance is the descriptions and quantities. The descriptions of work are seen to be effectively independent when used for pricing and also independent when used in five of the six planning tasks. However the quantities of measured work, prepared from the architect's drawings, are dependent upon other information every time they are used.

The response of the interviewers with respect to the utility of the quantities measured and recorded in the bill is conditioned by the absence of any guarantee that these are accurate representations of the building as designed. Were the contractors' estimators to check the quantities in detail then the benefit of a single bill for all competitors would be substantially reduced. Were the estimators responsible for the quantities (as in the United States of America) then the method of measurement would be related to purchasing and production. It follows that the current method of measurement demands some strong assurance, if not indeed some guarantee, for its continuance to be justified in the eyes of those tendering.

Although the prime costs and provisional sum section of the bill is seen to be an independent source of information this is more likely explained by the fact that no other pertinent information is available to the contractor at the time of tendering.

4.1.4. Conclusions

The format of bills of quantities is derived principally from an attempt to provide competing contractors with a factual common basis upon which to tender. The essence of the tender is seen to be the total price. That of subsequent matters of measurement and payment is to be found in the unit rates. To this end the format of the information in the bills of quantities is well suited to the needs of tender pricing, but does not satisfy so completely those of tender planning.

The presentation of information in the preliminaries section is suitable for the needs of planning and pricing. The content of the preliminaries, however, although substantially adequate for all tendering purposes is seen to be inadequate in the details describing the site and its location and the statutory requirements. This constitutes a shortfall in the achievement of the bill to reach its objectives.

Those inadequacies dependent upon the contractors' initiative in pursuing enquiries at the designers' offices or at the site, can not all be anticipated in the bill. This appears to be particularly so with regard to contractor's overheads. Process, manning and layout are aspects of method. These are recognised to be elements of contractor expertise which bear upon his competitiveness. How far then description has to go, or indeed should go, in order to provide an equitable basis for all tenderers is a matter of judgement on the part of any drafting committee.

In this respect description should presumably ensure that tenderers make their offers on the same factual basis. Statutory details are a case in point. Whenever a statutory obligation requires the payment of a fee or charge, directly affects the contractor's method, time or duration of working, the tools to be used or not used, imposes restrictions on the contractor's free use and access to the site, then such items should be seen to be equitable as between competing contractors. It is not apparent that by classifying the bill as inadequate in this respect those concerned were inclined to expect more than equity might permit.

The details of specification included in preamble clauses generally appear to satisfy the demands of tendering. However, those specific details which describe the handling and placing of materials appear to be of little benefit either for planning or pricing. Again there is a conflict between description and method. If it is the intention of existing rules of measurement that the preamble clauses should be complete, then this inadequacy is a matter of concern.

It is observed that while the present method used for measuring building work presents quantities suitable for the procedure of tender pricing, they are not seen to satisfy that of tender planning. It is also evident that neither the planning nor pricing activities regard the substance of measured data as totally satisfactory. There is a conflict centred upon the competitive significance of contracting method. Added description or quantity

may be seen to encroach upon the responsibility of contractors for method, however, if method is less significant as a competitive factor than is supposed, then there may well be ambiguities of interpretation of bill items.

The most significant area of dissatisfaction with the bill centres upon the items of nominated sub-contractors' work and provisional sums. Frequently these items represent a large proportion of some tenders and often reflect delayed decisions or incomplete designs. If such practices are to continue on their current scale then some review of the format and content of the bill in respect to these items is clearly necessary.

The independence of information is composed of parts, (reference to standards, catalogue numbers etc.) which should be common to all tenderers, and parts which are derived from the capabilities of the firms (gained from their own records and practices). The latter part clearly cannot be introduced into the bill, thus some items are bound to be dependent upon the support of additional data, while others are not. Financial details are an example of the latter. In the measured items, the substance of the bill, a large measure of independence is achieved by current practice as regards description. If, however, an absence of guaranteed quantities lends itself to weighting exercises during estimating, then a demand for additional information may be generated. This may explain some of the inadequacies and the dependence of the bill upon other data. However any dependence of the bill upon other information which stems from its inadequate description to define precisely what is expected of

the contractor, must be viewed with concern. In particular the quantities of work are dependent upon the support of other information every time they are used, a factor which must be taken into account in reviewing the form, content and utility of the document throughout the contract, rather than just in the process of contractor selection.

4.2. Production Planning

4.2.1. The Suitability of Format

Planning is concerned with process, the process of production and utilization of goods and services, men and machines to achieve the client's objective. The essence of planning is to forecast time and method, and to quantify what is required, when and where. The achievement is a working hypothesis by which the company may reach a satisfactory conclusion. It is evident that precision and accuracy are critical, and yet even with the greatest skill and attention to detail the plan can only be as reliable as the information from which it is produced.

Excluding the rare event of major revision to the design subsequent to the tender and prior to the preparation of the production plan, the contract documents, including the bill, form the substantive information available from the designer. They are factual statements of the client's requirements as used to prepare the tender. One may reasonably expect, at this stage of the contract,

that the detail of the bill regarding the specification of what is required and the definition of the site and any external constraints, should satisfy the contractor's consideration up to the point of feasibility. However, since the essence of the bill does not concern itself with the problems of process, one would also reasonably expect the planning function to find areas of unsuitability and deficiency in its use of the bill.

It is observed from Figure 11 that the bill is well used for production planning and that the manner of presentation in the preliminaries and preambles is suitable, although this gives way to unsuitability in the measured work and prime costs and provisional sums. Regarding content, the bill appears to make the most effective contribution to planning with the preliminaries section.

The manner of structuring the locational information, package 13, is regarded as being inappropriate since the bill, normally caters for locational divisions which are evident in a finished structure, such as blocks, floors or levels and elements, rather than stages of the production process.

The quantities are not highly regarded by the planner either with respect to their mode of presentation or adequacy. He is concerned to arrange the factors of production in such a sequence and in such quantities as to achieve the desired rate of production.

The quantities provided in the bill are not based upon the process criteria, and therefore, although they are used they are seen to be inadequate. Variations and alterations react upon resources

O = Suitable Format
 X = Unsuitable Format

	Strategic Planning										Tactical Planning		
	Package No.	Appoint Agent etc.	Select Engineer and Sub Agent	Site Facilities	Plan Construction Method	Select Trade Foreman etc.	Review Contract Period, Tender dates	Prepare approx Programme	Examine Buying File	Insurances	Identify major initial Construction	Select work for sub-letting	Check Measure Main Quantities
Project Details	1	O	O		O	O		O		O	O	O	
Site and Location	2	O	O		O	O		O	O	O	O		
Form of Contract	3						O	O		O	O		
Times and Phasing	4	O	O		O	O	O	O	O	O	O		
Financial Details	5							O		O	O		
Statutory Details	6							O		O	O		
Facilities and Services	7			O	O			O		O			
General Responsibilities	8							O		O	O		
Material Specification	9				O			O	O				
Workmanship	10				O			O	O		O	O	
Handling	11				O			O	O		O	O	
Tests and Samples	12				O			O	O		O		
Locational Information	13				X			X	X		X	X	
Quantities	14				X	X		X	X		X	X	
Quantity Units	15				X	X		X	X		X	X	
Rates	16				X			X	X		X	X	
Extensions	17				X			X			X		
Totals	18				X			X			X		
Descriptions	19				O			O	O		O	O	
Description Dimensions	20				O			O	O		O	O	
Provisional Quantities	21				X			X	X		X	X	
Temporary Work	22				X			X			X	X	
Demolition	23				O			O			O	O	
Nominated Suppliers	24				X			X					
Nominated Sub-Contractors	25				X			X					
Provisional Sums	26				X			X					
Contingency	27												

FIGURE 11

SUITABILITY OF FORMAT FOR PRODUCTION PLANNING

which in turn relate to method, thus by excluding method the equity of contractor selection may be gained at the expense of prolonged discussion and compromise on claims. The process of tender planning and pricing must exert an influence upon the effectiveness of contractor selection, whereas any shortcomings the bill may have when it is used for production planning is simply a matter which affects performance and the feedback of information. A bill which impedes effective tender planning and pricing is failing in its primary purpose. The suspicion is that if production planning is impeded by inadequacies of information then the tender itself may have lacked essential data.

The unit rates, extensions and totals are intended to serve as a basis for compiling a tender sum, agreeing interim payments, and inevitably, variations and the settlement of accounts. Cost control affords the facts upon which the structure should be erected, but this is separated from estimators' rates by matters of contractor's records and judgement. However, it is significant that these rates are used by the planner despite the fact they are seen to be unsuitable and inadequate. It appears that a closer relationship of the elements of price and cost through the measurements in the bill of quantities would be of general benefit.

It appears in Figures 11 and 13 that the descriptions of work are considered by the planner to be suitable in both aspects of presentation and content. These descriptions describe the work fixed in position and complete and appear to serve as a common

denominator tying together the various factors of production in such a way that experience gained may be related to other projects.

Despite all their shortcomings, Figures 11, 12 and 13, the prime cost sums, particularly those relating to nominated sub-contractors work, are used to prepare the construction method and the approximate programme. However, the detail so essential to the planner is clearly absent from these items. It follows that a significant part of the work is dependent for production planning on advice and negotiation, in the absence of which the planner must fall back on rules of thumb or precedent. In tenders where a competitive element of substance may be derived from method it would appear that the concept of equity is not observed. Indications in the bill of the time periods upon which nominated sub-contractors' work is to be priced, the delays or delivery periods expected for nominated suppliers' items might contribute to greater equity. The production planner is also concerned to know, in the case of nominated sub-contractors' work, the type of installation and form of construction, again areas in which the bill is seen to be inadequate. It is of course possible that a solution to the inadequacy of the prime cost and provisional sum items, used at the tender stage, would obviate the need for them in that form at all.

A summary of the different information packages used for the production planning is seen in Figure 12. The twelve totals in "production planning format" of Figure 12 correspond to the points in production planning, f to r, where the use of the bill is

Vertical Scales = Number of Recorded Uses.

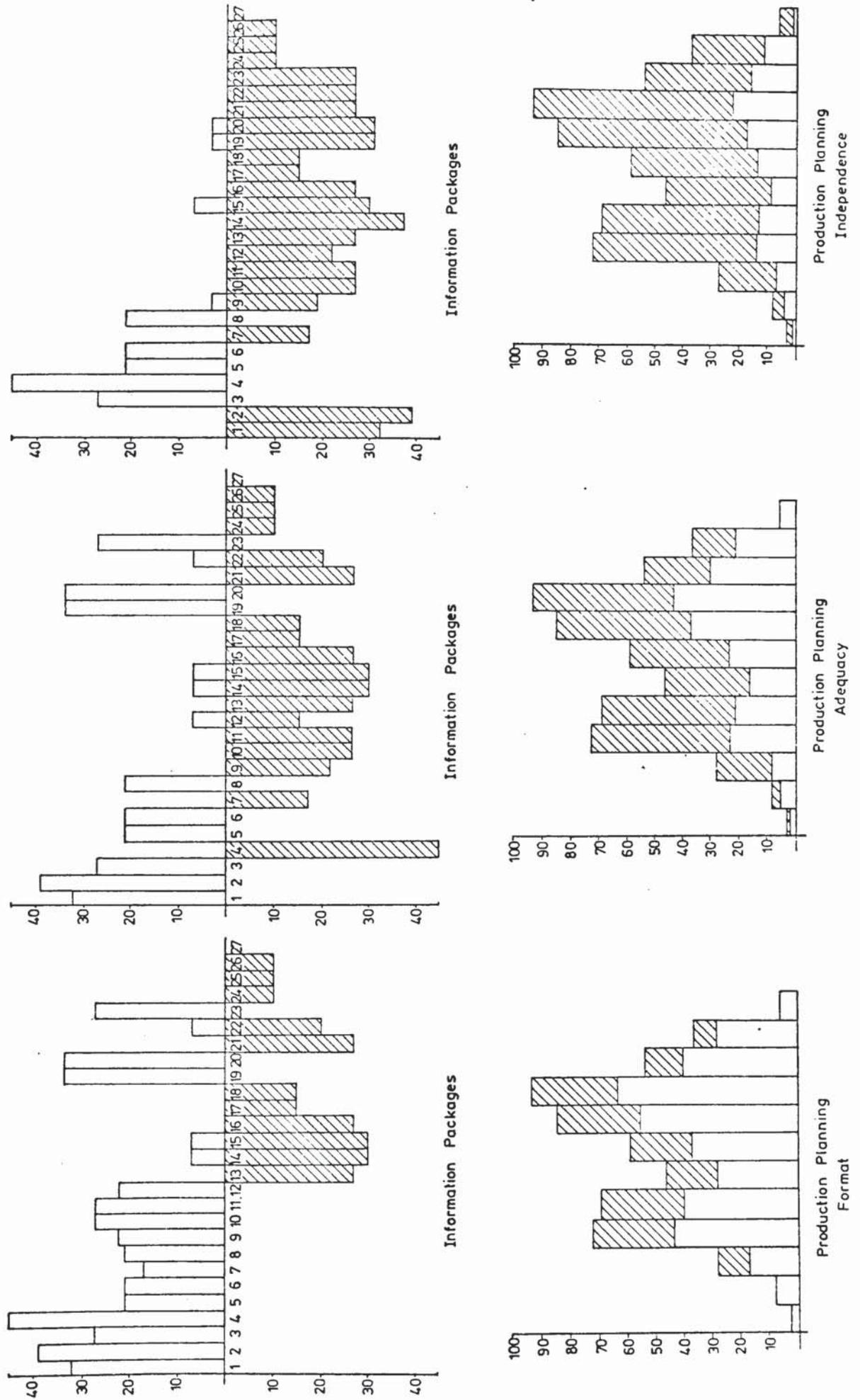


FIGURE 12
 PRODUCTION PLANNING - FORMAT, ADEQUACY AND INDEPENDENCE

observed to change on the programme of integrated tasks in time order, Figure 5 of Chapter III. Unlike the pattern which the use of the bill makes for tendering in which the maximum use is reached at the outset, in production planning it is observed that the use of the bill slowly increases to a maximum and then declines.

It is also apparent from Figure 12 that planners appear to have a different regard for the adequacy of the information than they have for its format. Two thirds of the information used is considered to be suitable in format, but only one third of the information is considered to be adequate.

4.2.2. The Adequacy of Information

That the bill will contain much information regarded as being incomplete for production planning is only to be anticipated since the mind of the person drafting it is directed toward providing that which is required for the calculation of the tender sum. The requirements of production planning are not immediately recognised as being consistent or even fundamentally compatible with such an objective. However, as already shown, aspects of production planning bear heavily upon the process of tender, and inadequacies for one purpose may well bring into question the adequacy of the bill to serve the other.

It appears from Figure 13 that a number of specific items of information are considered inadequate with respect to planning.

○ = Information Adequate
 × = Information Inadequate

	Strategic Planning										Tactical Planning		
	Package No.	Appoint Agent etc.	Select Engineer and Sub Agent	Site Facilities	Plan Construction Method	Select Trade Forman etc.	Review Contract Period, Tender dates	Prepare approx Programme	Examine Buying File	Insurances	Identify major initial Construction	Select work for sub-letting	Check Measure Main Quantities
Project Details	1	○	○		○	○		○		○	○	○	
Site and Location	2	○	○		○	○		○	○	○	○	○	
Form of Contract	3						○	○		○	○	○	
Times and Phasing	4	×	×	×	×	×	×	×	×	×	×	×	
Financial Details	5							○		○	○	○	
Statutory Details	6							○		○	○	○	
Facilities and Services	7			×	×			×		×	×	×	
General Responsibilities	8							○		○	○	○	
Material Specification	9				×			×	×		×	×	
Workmanship	10				×			×	×		×	×	
Handling	11				×			×	×		×	×	
Tests and Samples	12				×			×	○		×	×	
Locational Information	13				×			×	×		×	×	
Quantities	14				×	×		×	×		×	×	○
Quantity Units	15				×	×		×	×		×	×	○
Rates	16				×			×	×		×	×	
Extensions	17				×			×			×	×	
Totals	18				×			×			×	×	
Descriptions	19				○			○	○		○	○	○
Description Dimensions	20				○			○	○		○	○	○
Provisional Quantities	21				×			×	×		×	×	
Temporary Work	22				×			×			×	×	○
Demolition	23				○			○			○	○	○
Nominated Suppliers	24				×			×					
Nominated Sub-Contractors	25				×			×					
Provisional Sums	26				×			×					
Contingency	27												

FIGURE 13

ADEQUACY OF INFORMATION FOR PRODUCTION PLANNING

Any inadequacy of information which reflects earlier comments on unacceptable format and content is discussed in the section headed format.

Particular shortcomings in the preliminaries centre upon the details of times and phasing and the facilities and services to be provided. The client requirements regarding the possession, completion, phasing or partial completion of the work are fundamental to the realistic completion of the tender but equally so to the preparation of the plan and the production programme, and should, as a matter of basic necessity, be complete and precise when entered in the bill. Consideration of Figure 12 will reveal that this item of information, despite any inadequacy, is regarded as an independent source of information. Most likely this itself is an indication that there is no substitute to which the contractor may turn.

In the absence of precise details of facilities and services there must obviously be problems of interpretation. Since this area of information is considered to be deficient there is clearly some conflict of view as to what constitutes acceptable information.

The preamble clauses should, in all but the most obvious contrary situations, be written and prepared for each particular job. Manufacturers' addresses, catalogue references, qualities of material and components should be current. Standards and performance requirements of materials and workmanship should be realistic, having regard to the quality of material available, the quality of material being used, the working properties of the material, the type of building

being constructed and the standard of workmanship normally expected in such a class of work. Designers should ensure that information is supplied to ensure that materials and standards of workmanship given in preamble clauses are appropriate. They are largely seen to be inadequate in this respect, although this may be rather a criticism of practice than intention.

4.2.3. The Independence of Information

It is readily observed in Figure 14 that most of the information given in the bill is dependent upon the support of supplementary data when used for production planning although it is also clearly evident that the larger part of the preliminaries section is viewed as being totally independent. No other information outside the preliminaries appears to be totally self sufficient and yet specific items, notably material specification and the descriptions of work, are independent when used for specific purposes.

It is difficult to ascertain whether the reliance of the bill upon other sources of information is a consequence of inadequacy, or whether the contractor would be obliged in the execution of particular tasks to make reference to his own documents. It should not necessarily be regarded as a deficiency on the part of the bill that other information is used. A specific case in point is that of the descriptions of work. Figures 11, 13 and 14 clearly show a favourable response on the part of the planner toward the

O = Information Independent
 X = Information Dependent

	Strategic Planning									Tactical Planning			
	Package No.	Appoint Agent etc.	Select Engineer and Sub Agent	Site Facilities	Plan Construction Method	Select Trade Forman etc.	Review Contract Period, Tender dates	Prepare approx Programme	Examine Buying File	Insurances	Identify major initial Construction	Select work for sub-letting	Check Measure Main Quantities
Project Details	1	X	X		X	X		X		X	X	X	
Site and Location	2	X	X		X	X		X	X	X	X	X	
Form of Contract	3						O	O		O	O	O	
Times and Phasing	4	O	O		O	O	O	O	O	O	O	O	
Financial Details	5							O		O	O	O	
Statutory Details	6							O		O	O	O	
Facilities and Services	7			X	X			X		X	X	X	
General Responsibilities	8							O		O	O	O	
Material Specification	9				O			X	X		X	X	
Workmanship	10				X			X	X		X	X	
Handling	11				X			X	X		X	X	
Tests and Samples	12				X			X	X		X	X	
Locational Information	13				X			X	X		X	X	
Quantities	14				X	X		X	X		X	X	X
Quantity Units	15				X	X		X	X		X	X	O
Rates	16				X			X	X		X	X	
Extensions	17				X			X			X	X	
Totals	18				X			X			X	X	
Descriptions	19				O			X	X		X	X	X
Description Dimensions	20				O			X	X		X	X	X
Provisional Quantities	21				X			X	X		X	X	
Temporary Work	22				X			X			X	X	X
Demolition	23				X			X			X	X	X
Nominated Suppliers	24				X			X					
Nominated Sub-Contractors	25				X			X					
Provisional Sums	26				X			X					
Contingency	27												

FIGURE 14

INDEPENDENCE OF INFORMATION USED FOR PRODUCTION PLANNING

presentation and content of description, but yet the information is dependent upon other documents in all but one task where the information is used. It seems likely in this circumstance that the planner is complementing the bill rather than resolving some weakness or deficiency. In the case of the quantities and prime cost sums however it is likely that part of the necessity to consult other information is directly related to the unsuitable presentation and the inadequate content. It is also equally likely in this case that part of the reference is essential to introduce the individual performance and specialisms of the company to the plan and would therefore be necessary irrespective of form or content of the bill.

It is apparent from Figure 12 that only four out of twenty six information packages which are used for production planning are seen to provide an independent source of reference.

4.2.4. Conclusions

Planning is not a process which the bill has been designed to serve, nor is it evident that any special regard is given in its preparation to whether the requirements of the production planner correspond in any way to those of tendering.

The bill should, excluding those circumstances where major revisions occur immediately after tender, represent to the production planner at the outset of his task the same authoritative factual statement of the client's requirements which it did for tendering.

It appears that this is not entirely so. In particular information of preliminary detail and material specification, considered to be quite adequate in content when preparing the tender plan appears inadequate when precision and reality are introduced by the production planner.

The reality of the planner's work is governed by the quality of information he uses. That the preamble clauses are seen to be inadequate for production planning suggests that designers might contribute to more effective contract performance by communicating their intention with greater precision and clarity. Preamble clauses should presumably reflect the work to be completed and should achieve compatibility between the quality of material and the standards of workmanship.

It is clear, despite shortcomings, that the preliminary section of the bill affords the greatest relative benefit to the planner.

The details of times and phasing from the preliminaries appear to lack the precision necessary for the contractor's exact commitment. In this matter where the client regards time to be of the essence, his requirements should be stated precisely.

The facilities and services is a further area of preliminary detail which appears inadequate and which must point to a lack of definition of what constitutes acceptable information.

Planning is a process concerned with forecasting the method and timing of production and the utilization of components and commodities. It appears to be inevitable with present documentation that problems of presentation will arise with the measured work section when the bill is used for planning since the principal concept of building measurement is the representation of completed work, i.e. the product, rather than the process. The organisation and presentation of the locational details follow the same principle of grouping work into locations which are evident within a finished structure.

Process is the major conflict concerning the measured work section of the bill. The quantities themselves are poorly regarded for this reason and are considered to be unsuitable in format despite their use. Since the same dichotomy exists toward the quantities in the tendering process one is led to question whether the tender tends to lack critical data.

The estimator's prices appear to be helpful to the planner despite their format and lack of detail. The critical problems of marrying design and production and relating costs to prices are particularly evident in production planning. The evidence of this research supports the view that a closer and more direct relationship between costs and prices through measurement would benefit firstly the planner, secondly cost control procedures, and ultimately the client.

Process and product should not necessarily be regarded as mutually exclusive methods of presenting data. The descriptions of work, which represent a substantial proportion of the bill, are regarded by the planner as being suitable and adequate for his purposes despite the fact they describe the finished piece of work.

The inefficiency of prime cost items gives rise for concern. These items fail to communicate information seen to be pertinent to the work they represent and which is essential to an accurate forecast. It would be a critical failing if designers did not recognise the significance which such items have upon the construction process by introducing uncertainty, and thus a risk for which provision should be made, and also failed to recognise the effect which scanty information has upon the credibility of a forecast. The continuing use of prime cost sums in the bill maintains a strong likelihood that disputes and delays will involve argument over time, sequence, performance and payments.

The division of the bill's dependence upon other data appears to fall into a number of categories:- (a) that portion essential to the performance and organisation of the contract, (description of work for instance), (b) that part made necessary by the criteria of process (the quantities), and (c) that made necessary by inadequacy of design communication.

It is neither likely nor desirable that the bill should present to the contractor a totally independent source of information, but equally too great reliance upon other documents should be viewed with some concern.

4.3. Buying

4.3.1. The Suitability of Format

Just as the process of production planning transforms the plan prepared for tender submission into a working statement, so too the buying function transforms the materials and sub-trade elements, so carefully priced by the estimator, into reality. The buying function should also be seen as a process dependent for its success upon judgement supported by detailed description and accurate quantity while taking time and price into consideration.

Although the flow and pattern of the buying sequence is constantly influenced by the time and method of production, buying itself contributes little to the establishment of time periods or sequence except in so far as availability dictates. Despite this, buying is still process orientated, seeking to secure the material and components, the plant and services at the right time and in the right amount to maximise production.

Unless the outcome of the orders is to produce what any other tenderer would have produced then the bill fails in its objective of affording a fair and common basis to tenderers.

Although the bill of quantities is not presented to the contractor as a buying document most of the information it contains is well used, (Figure 15).

O = Suitable Format
 X = Unsuitable Format

	Plant		Materials			Domestic Subs			Nominated Subs/Supp		
	Package No.	Select Plant prepare Method Statement	Procure Plant	Measure for Ordering	Review Tender Docs. and Quotations	Develop Enquiry	Decision to Sub-Contract	Review Tender Docs. and Quotations	Develop Enquiry	Review Tender Docs.	Select Supplier / Sub - Contractor
Project Details	1	O			O	O	O	O	O	O	O
Site and Location	2	O	O		O	O	X	X	X	X	X
Form of Contract	3	O			O	O	O	O	O	O	O
Times and Phasing	4	O		O	O	O	X	X	X	O	O
Financial Details	5	O			O	O	O	O	O	O	O
Statutory Details	6	O	O		O	O	O	O	O	O	O
Facilities and Services	7		O					O	O	O	O
General Responsibilities	8	O					O	O	O		
Material Specification	9			O	O	O	O	O	O	O	O
Workmanship	10	O			O	O	O	O	O	O	O
Handling	11	O			O	O	O	O	O	O	O
Tests and Samples	12				O	O	O	O	O	O	O
Locational Information	13	X		O	O	O	X	X	X	X	X
Quantities	14	X	X	X	O	X	X	X	X		
Quantity Units	15	X	X	X	O	X	X	X	X		
Rates	16	X			X	X	X	X	X		
Extensions	17				X	X	X	X	X		
Totals	18				X	X	X	X	X		
Descriptions	19	O	O	O	O	O	O	O	O		
Description Dimensions	20	O	O	O	O	O	O	O	O		
Provisional Quantities	21	O			O	O	O	O	O		
Temporary Work	22	X		X	O	O	O	O	O		
Demolition	23	O			X		X	X	X		
Nominated Suppliers	24										
Nominated Sub-Contractors	25									X	X
Provisional Sums	26										
Contingency	27										

FIGURE 15

SUITABILITY OF FORMAT FOR BUYING

It is seen in Figure 15 that most of the descriptive information is presented in a manner considered suitable for the buying process, whereas the quantitative items are considered to be unsuitable. Two items of information from the preliminaries, the site and location and the times and phasing, are exceptions to this general observation.

The bill's description of the site and its location is considered by those responsible for the buying activity to be unsuitable in presentation and content. The same bill description was seen to be sufficient for estimating purposes when dealing with materials, labour, plant and domestic sub-contractors, but insufficient regarding its detail and content when used in conjunction with overheads. However at the buying stage these details of the bill are shown to be inadequate when used for buying all these items. Although the interpretation of the problems and difficulties relating to the site will, in the final sense, be the responsibility of the contractor, the detailed factual information concerning the site and its surroundings, pertinent to the contractor's need should be contained in the bill.

In the case of the details describing the timing and phasing of the contract both the form of presentation and content of the information is questioned. It is clear that the sequence and programme of buying will be influenced by the timing of possession, completion, phasing, sequence or partial completion of the work.

One would expect that such matters should be clear and equitable for all tenderers. The disparity of response as between the tendering and buying uses of the billed data is not to be viewed as an unconnected issue.

The practice of identifying the location of work within the building by blocks, floor and levels is considered to be helpful to the buying process, although the presentation of this information is criticised. However, the real criticism of inadequacy here relates not so much to the inappropriateness or inadequacy of the provision which some bills make, but rather to the general lack of provision.

The format of the descriptions of work is considered to be suitable for buying.

The quantities and the units of measurement, in essence the substance of the bill, are seen to be unsuitable in presentation and content for the needs of buying. Although this observation may be appreciated by the industry, this dissatisfaction should be viewed as part of the growing evidence of incompleteness which began with the tender preparation. It becomes increasingly evident that some quantity data, in addition to that currently provided, is very much required by the industry. It is also clear, since the bill is so well used, that no current document satisfies that need. However to satisfy such a need the existing rules of measurement for building work would have to be amplified.

The unit rates given by the estimator in the bill conceal a break-down of labour, material, plant, overheads and profit which has to re-emerge for purposes of purchasing control. If the basis of quotation at the time of tender differs from that based on the additional information of working drawings and architects instructions at the time of purchase then this difference reflects a variation (for which there is contractual provision) or misinterpretation. The latter would be a source of dissatisfaction with the bill.

As the representation of a major part of the construction work, prime cost items, particularly those relating to nominated sub-contractors' work, are regarded as being inappropriate to the needs of the buying activity particularly regarding their presentation and content. These items have also been discussed in the tendering and production planning procedures and shown to be totally unsuitable. The information given in these items is insufficient for the contractor to exercise the control necessary for efficiency. The presentation of information in this manner must be cause for concern and justification for change.

Figure 16 shows the summary of information packages used for buying. The five totals in 'buying format' of Figure 16 correspond to the five points of change l,r,s,t and x shown on Figures 5 and 6 of Chapter III, in the use of bill of quantities for buying. Approximately two thirds of the information used by the buying procedures is in a suitable format. Again, shown on Figure 16, the

Vertical Scales = Number of Recorded Uses.

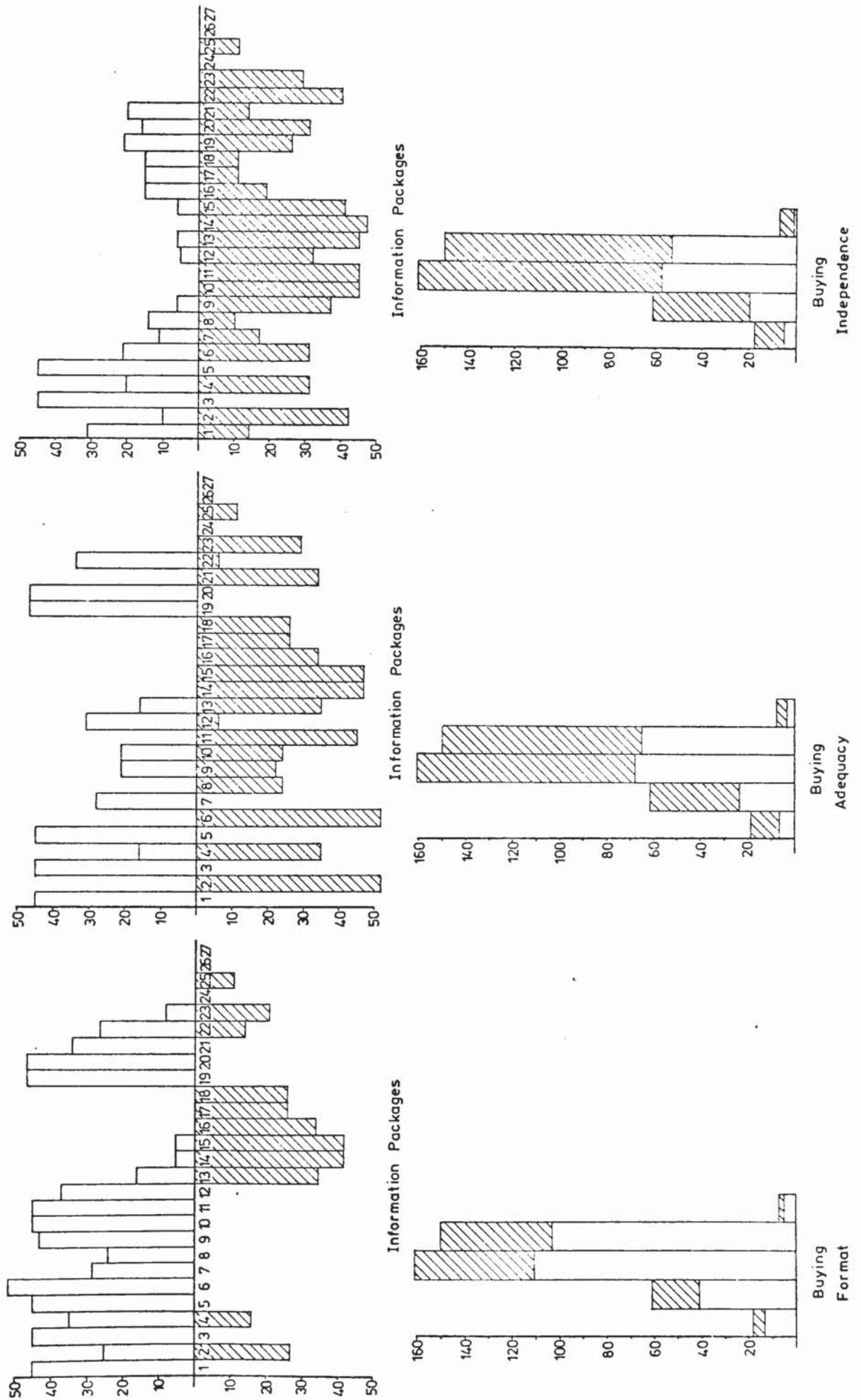


FIGURE 16
BUYING - FORMAT, ADEQUACY AND INDEPENDENCE

format of information when used for buying is apparently found to be either totally suitable or quite unsuitable.

4.3.2. The Adequacy of Information

It is not to be expected that the information given in the bill will be totally adequate for buying since the selection and purchase of materials, plant and services are influenced by the company policy and records, the experience and judgement of those involved with buying and the availability both regarding stocks and source of supply, none of which are expressed in the bill.

However in so far as the bill purports to convey to the contractor the clients wishes with respect to material specification, usage and handling, workmanship and the description of work one should expect in these matters that the information would be complete and adequate.

The response of those involved with the sequence of buying toward the adequacy of the bill is shown in Figure 17.

The items of information which are judged to be unsuitable in format and inadequate are discussed fully in the section headed format.

It appears that approximately half of the information given in the preliminaries is considered to be inadequate for buying. The statutory details and general responsibilities are two cases where

○ = Information Adequate
 x = Information Inadequate

	Plant			Materials			Domestic Subs			Nominated Subs/Supp		
	Package No.	Select Plant	prepare Method Statement	Procure Plant	Measure for Ordering	Review Tender Docs. and Quotations	Develop Enquiry	Decision to Sub-Contract	Review Tender Docs. and Quotations	Develop Enquiry	Review Tender Docs.	Select Supplier / Sub - Contractor
Project Details	1	○			○	○		○	○	○	○	○
Site and Location	2	x	x			x	x	x	x	x	x	x
Form of Contract	3	○				○	○	○	○	○	○	○
Times and Phasing	4	x			○	○	○	x	x	x	x	x
Financial Details	5	○				○	○	○	○	○	○	○
Statutory Details	6	x	x			x	x	x	x	x	x	x
Facilities and Services	7			○					○	○	○	○
General Responsibilities	8	x						x	x	x		
Material Specification	9				x	x	x	x	○	○	○	○
Workmanship	10	x				x	x	x	○	○	○	○
Handling	11	x				x	x	x	x	x	x	x
Tests and Samples	12					○	○	x	○	○	○	○
Locational Information	13	x			○	○	○	x	x	x	x	x
Quantities	14	x	x		x	x	x	x	x	x		
Quantity Units	15	x	x		x	x	x	x	x	x		
Rates	16	x				x	x	x	x	x		
Extensions	17					x	x	x	x	x		
Totals	18					x	x	x	x	x		
Descriptions	19	○	○		○	○	○	○	○	○		
Description Dimensions	20	○	○		○	○	○	○	○	○		
Provisional Quantities	21	x				x	x	x	x	x		
Temporary Work	22	○			x	○	○	○	○	○		
Demolition	23	x				x		x	x	x		
Nominated Suppliers	24											
Nominated Sub-Contractors	25										x	x
Provisional Sums	26											
Contingency	27											

FIGURE 17

ADEQUACY OF INFORMATION FOR BUYING

the information is seen to be deficient although the presentation is acceptable. The statutory details were regarded by the estimator as being incomplete when used to price the material, plant, sub-contractors and overheads. Those concerned with buying also consider this information to be lacking when used to select the correct, (i.e. acceptable), plant, purchase materials and sub-contract labour and organise the work of nominated sub-contractors.

The preamble clauses describing the quality of material to be used, the workmanship standards and the handling, lifting, storage and protection of material and components is seen to be inadequate. Even when allowance is made for the changes resulting from architects' instructions there seems no valid reason why this information, chosen at the tender stage, should be regarded generally as being inadequate. The inadequacy must also raise the question of whether quality suffers some pressure of competitive interpretation in the buying phase. If it does then as far as the client is concerned all tenderers did not quote on the same basis.

It is clearly evident from Figure 16 that the division of information between that regarded as being adequate and that regarded as being inadequate is not simply grouped, as in the case of suitable and unsuitable format, between quantitative and descriptive information, nor does a division fall between the sections of the bill but rather is widespread throughout the document.

4.3.3. The Independence of Information

It is seen in Figure 18 that the greater part of the information provided in the bill is dependent upon reference to other information although individual areas of the bill are seen to be independent for specific tasks.

Three areas of information from the preliminaries, the project details, the form of contract and the financial details appear to serve buying well.

Reference to Figure 16 shows that the descriptions of work appear to be suitably presented and adequate, but largely dependent upon other information. As in the case of production planning where the descriptions of work were also dependent upon other information, it is also likely here that the contractor is complementing the bill rather than resolving a weakness.

The quantities and units of measurement are seen to depend upon other information. It is likely that part of the need to consult other sources of information is due to the fact that both the presentation and the content of the quantities are seen to be inadequate.

It is apparent from Figure 16 that only two out of twenty four information packages are seen to provide an independent source of reference for buyers.

O = Information Independent
 X = Information Dependent

	Plant			Materials			Domestic Subs			Nominated Subs/Suppliers		
	Package No.	Select Plant	prepare Method Statement	Procure Plant	Measure for Ordering	Review Tender Docs and Quotations	Develop Enquiry	Decision to Sub-Contract	Review Tender Docs and Quotations	Develop Enquiry	Review Tender Docs.	Select Supplier / Sub - Contractor
Project Details	1	X			O	O		X	O	O	O	O
Site and Location	2	X	X		O	O		X	X	X	X	X
Form of Contract	3	O			O	O		O	O	O	O	O
Times and Phasing	4	O			O	X	X	O	X	X	X	X
Financial Details	5	O				O	O	O	O	O	O	O
Statutory Details	6	O	O			X	X	O	X	X	X	X
Facilities and Services	7			X					X	X	O	O
General Responsibilities	8	O						O	X	X		
Material Specification	9				O	X	X	X	X	X	X	X
Workmanship	10	X				X	X	X	X	X	X	X
Handling	11	X				X	X	X	X	X	X	X
Tests and Samples	12					O	X	X	X	X	X	X
Locational Information	13	X			O	X	X	X	X	X	X	X
Quantities	14	X	X		X	X	X	X	X	X		
Quantity Units	15	X	X		O	X	X	X	X	X		
Rates	16	X				O	X	X	O	O		
Extensions	17					O	X		O	O		
Totals	18					O	X	X	O	O		
Descriptions	19	X	X		O	O	X	X	O	O		
Description Dimensions	20	X	X		O	X	X	X	O	O		
Provisional Quantities	21	X				O	O	X	O	O		
Temporary Work	22	X			X	X	X	X	X	X		
Demolition	23	X				X		X	X	X		
Nominated Suppliers	24											
Nominated Sub-Contractors	25										X	X
Provisional Sums	26											
Contingency	27											

FIGURE 18

INDEPENDENCE OF INFORMATION USED FOR BUYING

4.3.4. Conclusions

The bill is well used for buying purposes despite the fact that it is not presented as a buying document or arranged in a manner to afford the greatest utility to the buying function.

To meet its tendering objectives the descriptive element of the bill should present an authoritative, precise and complete statement of the client's requirements. This applies equally and with no radical change to buying. It is evident that this is not the case. Information in preliminaries giving details concerning the site and its location, is considered adequate to price the materials, labour and plant, but inadequate when the items are purchased. Again the detail of times and phasing are regarded as being quite suitable for all the activities of pricing, but again inadequate for buying. The content of these items of information does not appear to satisfy the need of usage, which must bring into question the reality and completeness of the information presented for use by the estimator.

The shortcomings of the statutory details identified by the estimator when used for pricing are also identified when the information is used for buying labour, material and plant. This information appears to be lacking essential detail.

The definition of materials, workmanship standards, handling and protection is possibly the most crucial element of the bill for buying. These items in particular should represent the same precise

and accurate statement of the client's requirements to buyers as they did to the estimator, but clearly this is not the case. The apparent difference in utility derived from the preambles by estimating and buying may be explained by variations to the contract, but if variation is the sole or major cause for this difference then concern must be felt about the financial implications of any permitted design changes. It is likely, in part at least, that this information lacks something of the precision and exactness essential for buying, and therefore fails to go beyond the point of establishing within a scale, the order of magnitude. If the quality of materials and components, the standards of workmanship or protection is open to question or interpretation then the bill cannot be said to have provided tenderers with an equitable common basis.

The criticism made of the location information by buying does not relate to its structure or presentation as in the case of production planning but rather to the general lack of provision.

The quantities and units of measurement are part of the quantitative data given in the bill which is seen to be inappropriate to the needs of buying. The quantities do not represent the amount to be purchased nor do the units of measurement necessarily represent those which appear on an order. The format of the quantities, although suitable for tendering purposes, is seen to be unsuitable for buying. It may be concluded that the units of measured work fixed in position, a unit considered appropriate by the contractor to relate his experience from one

contract to another, is not necessarily adequate in the buying process.

The unit rates are unsuitable and inadequate as presented in the bill for buying purposes. Neither the units of measurement nor the unit rates identify any of their component factors. Where the selection of the contractor is not dependent upon competitive tender but the bill is prepared to provide a basis for measurement and payment, there is a clear case for departure from the current Standard Method of Measurement towards a material schedule more closely related to the materials constituting the building for which the client has contracted.

The format and content of prime cost sums is inadequate for buying. The presentation of work to the contractor in the form of prime cost sums means that a major area of purchasing lies outside his control from the outset of the contract. The risk and uncertainty extends into matters of process, site works, and overheads and must be recognised as being part of such a system.

Few areas of information from the bill provide buying with an independent source of information. Although the items of information considered to be inadequate may explain part of the bills' dependence upon other data, the general reference to other information should not be regarded necessarily as a criticism since many factors such as construction procedure and progress, company buying policy, experience of the buyer and variation orders will all bring an influence to bear upon purchasing and the need for data.

4.4. Manufacture Distribution and Control

4.4.1. The Suitability of Format

Having gained access to the site, assembled items of material and plant, and engaged the necessary labour the time has arrived to begin the site production process. The responsibility of the site manager is to complete that building for which the client has contracted to pay. The whole interactive process thus far has created the environment for the prosecution of the work. The contract duration is part of the client's expectation, the process will be determined by a sequence of events and their impact on the production plan, the cost parameters within which he must work will long since have been established by the estimator. Never-the-less his principal task is to draw all these different parts of contract performance together and achieve a successful outcome. This involves quality and delivery at a price.

To this end the bill plays an important part. It is the basis for inspection, acceptance, measurement and payment. Quality, in so far as it refers to acceptance, is acknowledged in principle as a step towards payment (discussed in section 5 which follows).

It is shown in Figure 19 that these production procedures make use of the preambles, the quantities and the descriptions of work. The only information used from the preliminaries are those describing the site and its location, which are used in conjunction with the process of off-site manufacture and delivery.

○ = Suitable Format
 x = Unsuitable Format

	Package No.	Manufacture		Distribution and Control	
		Off-Site Manufacture and Delivery	On-Site Manufacture	On-Site Distribution	Controlling Quality Materials & W/ship
Project Details	1				
Site and Location	2	○			
Form of Contract	3				
Times and Phasing	4				
Financial Details	5				
Statutory Details	6				
Facilities and Services	7				
General Responsibilities	8				
Material Specification	9	○	○		○
Workmanship	10	○	○		○
Handling	11	○	○	○	○
Tests and Samples	12	○	○		○
Locational Information	13	x	x		
Quantities	14	x	x		
Quantity Units	15	x	x		
Rates	16				
Extensions	17				
Totals	18				
Descriptions	19	○	○		
Description Dimensions	20	○	○		
Provisional Quantities	21	○	○		
Temporary Work	22				
Demolition	23				
Nominated Suppliers	24				
Nominated Sub-Contractors	25				
Provisional Sums	26				
Contingency	27				

FIGURE 19
 SUITABILITY OF FORMAT FOR
 MANUFACTURE DISTRIBUTION AND CONTROL

The descriptive information that is used appears to be suitably presented for the requirements of manufacture distribution and control whereas the quantitative information does not. In particular the details of the site and its location and the descriptions of the work, the latter clearly representing a major part of the information provided in the bill, are seen also to be quite adequate in content for these production procedures.

The details describing the location, or point of inclusion into the structure, are not suitably presented for this work on site. The practice of subdividing the measured work into locational classifications is not widely adopted in bills of quantities. Indeed, the subdivisions used when the bill is arranged into locations can only suit the production if based on the sequence of activities adopted (and there are alternatives). It may well be that only the contractor can fully appreciate and predict the locational detail appropriate to production, since he is responsible for the process. That which best utilizes management, labour and machines is not easily visualized in isolation from events and in advance. However, since the competitive aspects of method are part of the initial offer, equity requires that any common factors and influences should be remarked upon.

The quantities are seen to be inappropriate when used for manufacture, distribution and control. Only when men, machines and materials have been successfully managed within the units of work, and the outcome measured and compared with the bill is a comparison possible. Production is more directly concerned with the process than product (which is the subject of the bill).

These shortcomings in measurement are perhaps more important to tendering than may first appear. The procedures adopted and the performance achieved by production will reflect the particular material, plant and labour used, the form of construction imposed by the design and the problems associated with the site.

The whole development of the production will inevitably be fed back to the estimator, either formally or informally, in order to improve the company's own efficiency and increase the accuracy of its estimates.

If the use of the quantities by production is not directly conducive to the process it is unlikely that the experience gained in production of procedures, output, performance and materials will be accurately or realistically incorporated into the single unit of measurement by the estimator.

It should be mentioned also that if building performance were to be specified and acceptance were to be subject to a process of commissioning and handover, rather than simply physical completion, then a new dimension of difference might be experienced.

Figure 20 shows the summary of all the information used for manufacture, distribution and control. The five totals in the 'format' diagram of Figure 20 correspond to the points where changes in the use of the bill by the procedures of manufacture distribution and control occur, points n,t,z,aa, and ab, on the programme of integrated tasks in time order given in Figure 5 and 6 of Chapter III.

Vertical Scales = Number of Recorded Uses

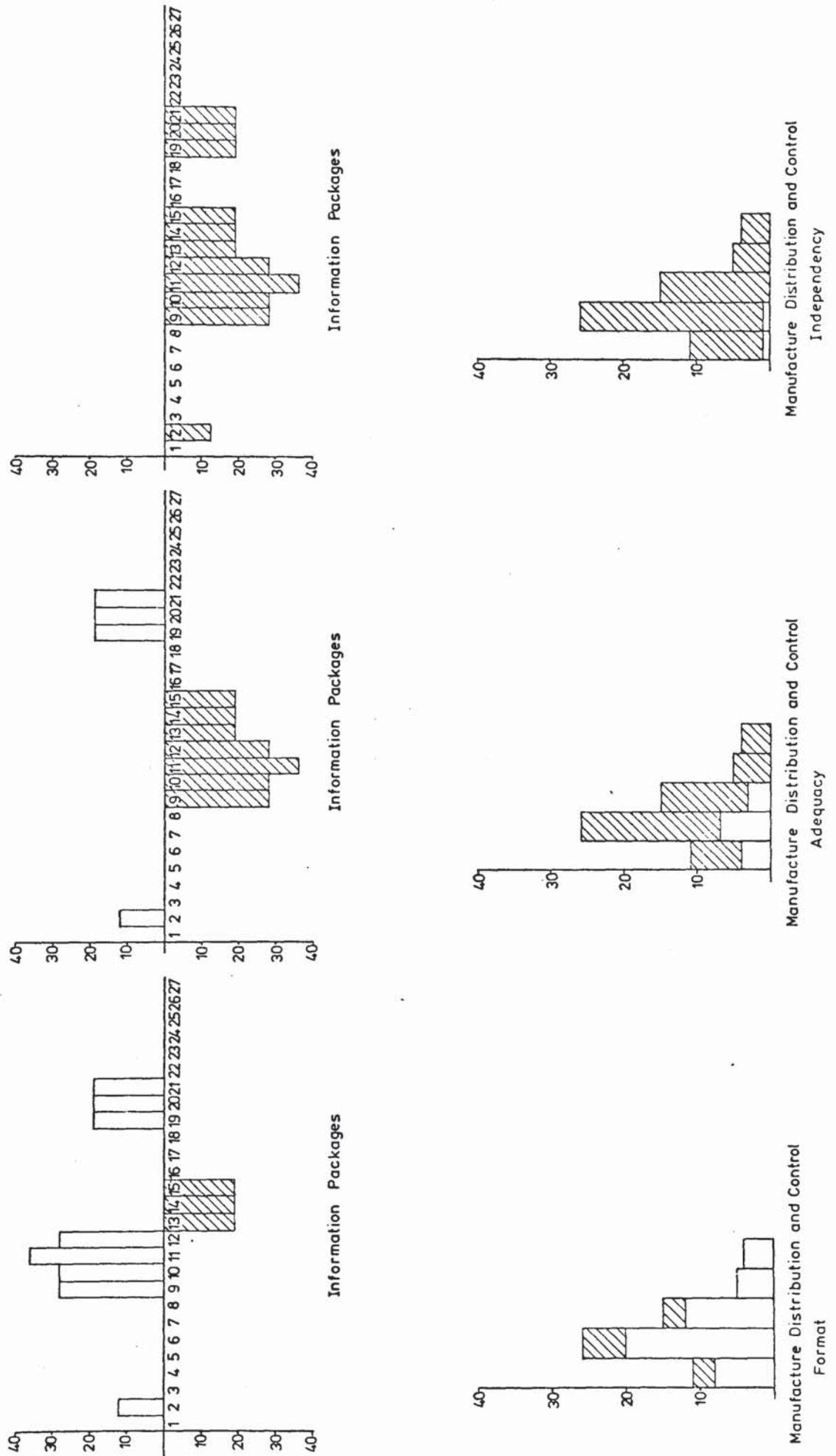


FIGURE 20
MANUFACTURE - FORMAT, ADEQUACY AND INDEPENDENCE

Of all the information used for manufacture distribution and control approximately seventy five percent is seen to be suitably presented and approximately thirty three percent is seen to be adequate. The preambles are used more than any other area of information and comparison of Figures 8, 12 and 20 show that the procedures of manufacture distribution and control make a greater total use of the preamble information than either the tender or production planning procedures.

4.4.2. The Adequacy of Information

Whether or not the information used in these procedures of production is seen to be adequate is shown in Figure 21. The inadequacy of the locational details and the quantities was discussed in the previous section concerning format where both these items of information were seen to be unsuitably presented.

The descriptions of work from the measured work section and the details of the site and its location are here seen to be adequate.

The whole of the preambles section is seen to be inadequate. However it is difficult here to ascertain whether, or in what proportion, the inadequacy arises as a result of insufficient information regarding standards and qualities, the omission of essential items of information, inaccuracies, or an emphasis upon description which does not directly benefit the process of

○ = Information Adequate
 x = Information Inadequate

	Manufacture		Distribution and Control	
	Package No.	Off-Site Manufacture and Delivery	On-Site Manufacture	On-Site Distribution Controlling Quality Materials & W/ship
Project Details	1			
Site and Location	2	○		
Form of Contract	3			
Times and Phasing	4			
Financial Details	5			
Statutory Details	6			
Facilities and Services	7			
General Responsibilities	8			
Material Specification	9	x	x	x
Workmanship	10	x	x	x
Handling	11	x	x	x
Tests and Samples	12	x	x	x
Locational Information	13	x	x	
Quantities	14	x	x	
Quantity Units	15	x	x	
Rates	16			
Extensions	17			
Totals	18			
Descriptions	19	○	○	
Description Dimensions	20	○	○	
Provisional Quantities	21	○	○	
Temporary Work	22			
Demolition	23			
Nominated Suppliers	24			
Nominated Sub-Contractors	25			
Provisional Sums	26			
Contingency	27			

FIGURE 21
 ADEQUACY OF INFORMATION FOR
 MANUFACTURE DISTRIBUTION AND CONTROL

construction. The inadequacies of preamble clauses become more evident as the contract moves from tender to production, and management attempts to implement the standards defined.

4.4.3. The Independence of Information

Figure 22 shows whether or not the information used from the bill is dependent upon the support of other data.

It is clear that all the information used, except the details describing the tests and samples required, is dependent upon other sources of information for completeness.

Subjectively one may anticipate the contractor using other documents in conjunction with the bill of quantities during the process of production. However, the research demonstrates that the format and content of information are seen to be inadequate in a substantial number of cases. This suggests that part, at least, of the dependence upon other data stems from the structuring and presentation of information in the bill.

4.4.4. Conclusions

In total the bill makes a smaller contribution to manufacture, distribution and control than at any other time.

○ = Information Independent
 × = Information Dependent

	Package No.	Manufacture		Distribution and Control	
		Off-Site Manufacture and Delivery	On-Site Manufacture	On-Site Distribution	Controlling Quality Materials & W/ship
Project Details	1				
Site and Location	2	×			
Form of Contract	3				
Times and Phasing	4				
Financial Details	5				
Statutory Details	6				
Facilities and Services	7				
General Responsibilities	8				
Material Specification	9	×	×		×
Workmanship	10	×	×		×
Handling	11	×	×	×	×
Tests and Samples	12	○	×		×
Locational Information	13	×	×		
Quantities	14	×	×		
Quantity Units	15	×	×		
Rates	16				
Extensions	17				
Totals	18				
Descriptions	19	×	×		
Description Dimensions	20	×	×		
Provisional Quantities	21	×	×		
Temporary Work	22				
Demolition	23				
Nominated Suppliers	24				
Nominated Sub-Contractors	25				
Provisional Sums	26				
Contingency	27				

FIGURE 22
 INDEPENDENCE OF INFORMATION USED FOR
 MANUFACTURE DISTRIBUTION AND CONTROL

The presentation of descriptive information is seen to be appropriate for its use, and one may conclude, since the descriptions of work are also considered to be adequate, that the production manager finds it beneficial in the execution of production to have before him the descriptions of completed work.

The manner in which the limited amount of locational subdivision occurs in the bill (blocks, floors, levels, etc.) is not dictated by production considerations, nor can it be without usurping some of the contractor's responsibility. Subdivision, into elements to aid cost-planning or into activities to relate costs to production, is possible but is not widely practiced. The reasons are many and are not sought here-in largely because such formats rarely appear as contract documents and thus do not lend themselves to the form of study. This failure to establish themselves must stand as evidence to the fact that other formats which might remedy some of the disadvantages of the trades bill are not so beneficial as to supplant it in common use.

The quantities, although used, are seen to be inadequate to quantify the component items within production. The inappropriateness of these units of measurement is further emphasized by the fact that the estimator's rates are not used. Indeed some firms issue only an unpriced bill to site managers. It may be that if the financial status of a contract is unhealthy then comparison might be made between the estimator's rate and the unit cost of some item in the bill. It could be that in times of stable currency value, however, more emphasis might be placed on price/cost relationships.

The preamble clauses are judged to be unsatisfactory in content, an observation which has repeatedly occurred in tendering, planning and buying. Should the deficiency stem directly from aspects of inaccuracy, incompleteness, omission or the failure to relate materials to standards of workmanship then there is good cause for concern. Where, however, an inadequacy stems from the basic concept of bill production, defining the product rather than the process, then any solution must necessarily be preceded by a review of the method of measurement. It should be recognised that efficient, accurate and precise clauses defining the materials and workmanship standards might well, in addition to aiding contractor selection, make a valuable contribution to production since their use for production purposes appears to be greater than at the time of tendering.

4.5. Payments

4.5.1. The Suitability of Format

The priced bill of quantities is the main financial control document on a building contract. It is a statement submitted by the contractor and accepted by the client of prices to be paid for work done.

The bill serves a greater variety of tasks in the payment area than any other. One might reasonably anticipate the strengths

/s

and weakness of the document to be similar in this instance to those observed for tendering.

It will be seen (Figure 23) that the item of claims does not appear as a task within the payment procedures. This omission is not because the bill of quantities is unused in the calculation of claims, but rather that no realistic summary could be presented in this research as representing normal use. The item of claims should rather be the subject of individual consideration in further work since every claim will have within it its own individual problem drawing together different information. The question of claims may, in one sense, be regarded as a summary of all other uses.

The whole of the information contained in the bill is well used for payment purposes and most of it appears to be presented in a format which is found to be suitable.

The information describing the site and its location and the facilities and services are two areas of the preliminary section where criticism of the presentation is observed. In the case of the site details these appear to be unsuitably presented particularly when used to settle the accounts of domestic and nominated sub-contractors. Although this may be regarded as a minor observation, it should be recognised that the same deficiency was also recorded in the buying section when this information was used to obtain the services of domestic and nominated sub-contractors.

○ = Suitable Format
 x = Unsuitable Format

	Package No.	Payments to the Contractor									Payments by the Contractor				
		Identify type of Construction Work	Size and Location of Contract	Review Tender Documents	Interim Valuations	Measure Variation Orders	Dayworks	Increased Costs	Domestic Sub-Contractors F/A	Nominated Subs/Suppliers F/A	Invoice received & paid for Matls	Invoice rec'd for Domestic Subs A/C	Measure and agree Domestic Subs A/C	A/C received for Nom. Subs/Suppliers	Measure & agree Nom. Subs/Supp. A/C
Project Details	1	○	○		○	○			○		○	○		○	○
Site and Location	2	○	○	○		○	○		○		○	x	○	x	
Form of Contract	3	○		○	○	○			○	○		○	○	○	
Times and Phasing	4		○					○	○			○			
Financial Details	5			○	○		○	○	○	○		○	○	○	
Statutory Details	6			○											
Facilities and Services	7		x		○	○	○		x	○		x		○	
General Responsibilities	8														
Material Specification	9					○	○	○	○		○	○			
Workmanship	10								○			○			
Handling	11					○	○		○	○		○		○	
Tests and Samples	12						○		○			○			
Locational Information	13				x	○					○				
Quantities	14				○	○		x	○			○	○		
Quantity Units	15				○	○		x	○		○	○	○		
Rates	16				○	○			○			○	○		
Extensions	17				○				○			○	○		
Totals	18				○				○			○	○		
Descriptions	19				○	○			○			○	○		
Description Dimensions	20				○	○			○			○	○		
Provisional Quantities	21				○										
Temporary Work	22			x	x	○									
Demolition	23				○	○			○			○		○	
Nominated Suppliers	24		○		x	x	x						x	x	
Nominated Sub-Contractors	25		○		x	x	x						x	x	
Provisional Sums	26						x								
Contingency	27						x								

FIGURE 23

SUITABILITY OF FORMAT FOR PAYMENTS

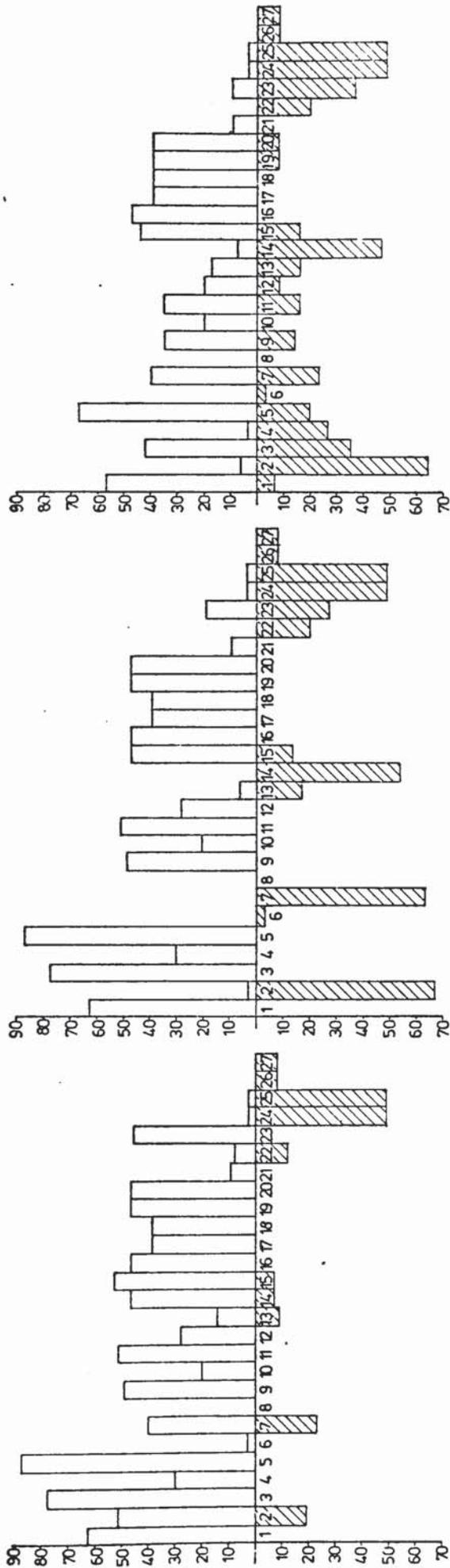
It is also in respect of the settlement of domestic sub-contractors' accounts that the facilities and services are seen to be unsuitable. These preliminary items are also seen to be inadequate (Figure 25) on almost every occasion that they are used.

Although the inadequacy of preliminary items may be explained by incomplete description, it is unlikely having regard to the criticism of presentation and content that such an explanation is valid. It may be that these areas of information do not present the contractor with the detail which, firstly, allows for an accurate presentation of the financial responsibilities likely to arise from the items, and secondly, the information does not appear to provide a sufficiently detailed mechanism whereby any variation of the constraints contained within these items may be equitably calculated and agreed between the parties.

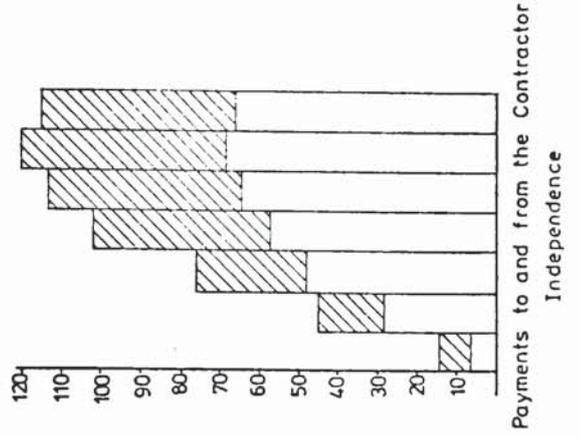
Since the bill of quantities serves the building industry as the major financial control document between client and contractor, establishing in detail the price to be paid for the work done, it must be a matter for considerable concern that items of nominated sub-contractors' work, which may often account for 50% of the total contract sum, are presented in a manner considered to be unsuitable and deficient both for pricing the initial tender and for controlling payments.

Figure 24 shows the summary of information used in the payment procedures. The seven totals shown in the "payment to and from the contractor - format" diagram correspond to the seven

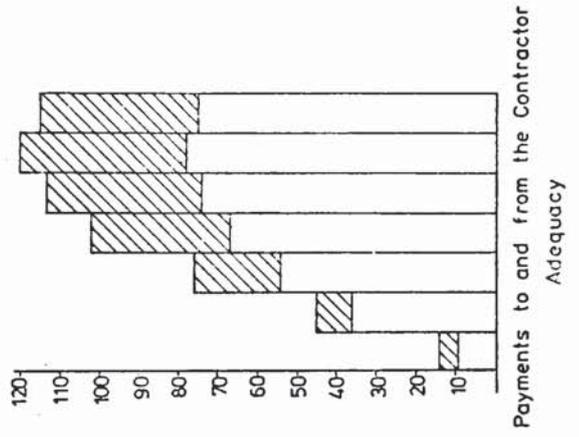
Vertical Scales = Number of Recorded Uses



Information Packages



Information Packages



Information Packages

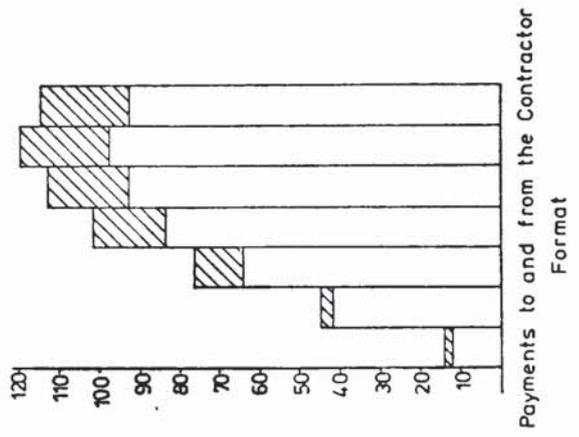


FIGURE 24
PAYMENTS - FORMAT, ADEQUACY AND INDEPENDENCE

points, l, u, v, w, x, y, and ad, shown in Figures 5 and 6 of Chapter III, where changes occur in the use made of the bill in payment procedures. Figure 24 also shows the total use made of the individual areas of information and whether or not these items of information are seen to be suitably presented and adequate. The response toward the details of site and location, the facilities and services, and the prime cost sums is clearly evident and gives cause for concern.

4.5.2. The Adequacy of Information

Any items of information provided in the bill of quantities, except those marked provisional and those where quantities of work have varied during the contract, which are judged to be inadequate for the purpose of settling accounts, must presumably have lacked some detail of cost significance when first used for tendering. It follows that any parameter of cost which cannot be directly or accurately incorporated into the tender, or readily identified and isolated, will, in the event of change, be likely to produce disagreement.

Where items of information are identified as being unsuitable in format and inadequate, the inadequacy is discussed in the format section.

The preambles are seen to be adequate for payment purposes. However this in itself is not necessarily an indication of

○ =
x =

		Payments to the Contractor										Payments by the Contractor				
	Package No.	Identify type of Construction Work	Size and Location of Contract	Review Tender Documents	Interim Valuations	Measure Variation Orders	Dayworks	Increased Costs	Domestic Sub-Contractors F/A	Nominated Subs/Suppliers F/A	Invoice received & paid for Mat's	Invoice rec'd for Domestic Subs A/C	Measure and agree Domestic Subs A/C	A/C received for Nom Subs/Suppliers	Measure & agree Nom. Subs/Supp. A/C	
Project Details	1	○	○		○	○				○	○	○		○	○	
Site and Location	2	○	x	x		x	x		x		x	x	x	x		
Form of Contract	3	○		○	○	○			○	○		○	○	○		
Times and Phasing	4		○					○	○			○				
Financial Details	5			○	○		○	○	○	○		○	○	○		
Statutory Details	6			x												
Facilities and Services	7		x		x	x	x		x	x		x		x		
General Responsibilities	8															
Material Specification	9					○	○	○	○		○	○				
Workmanship	10								○			○				
Handling	11					○	○		○	○		○		○		
Tests and Samples	12						○		○			○				
Locational Information	13				x	x					○					
Quantities	14				x	x		x	x			x	x			
Quantity Units	15				○	○		x	○		x	○	○			
Rates	16				○	○			○			○	○			
Extensions	17				○				○			○	○			
Totals	18				○				○			○	○			
Descriptions	19				○	○			○			○	○			
Description Dimensions	20				○	○			○			○	○			
Provisional Quantities	21				○											
Temporary Work	22			x	x	x										
Demolition	23				x	x			x			○		○		
Nominated Suppliers	24	○		x	x	x				x			x	x		
Nominated Sub-Contractors	25	○		x	x	x							x	x		
Provisional Sums	26						x									
Contingency	27						x									

FIGURE 25

ADEQUACY OF INFORMATION FOR PAYMENTS

completeness, nor should it be seen to cancel the observations made in the procedures of production planning, buying, manufacture, distribution and control. It is suggested that preamble clauses serve a some-what different function when used in conjunction with payments, than in any other procedure. Preambles are used in very specific ways to price, to plan, to buy and to construct, but in the payments area they are used largely for identification purposes. The surveyor will not be concerned with the accuracy of the preambles so far as they affect workmanship standards when the work is constructed and accepted, nor at the payment stage will any deficiency in the material specification be of great concern when the inadequacy has long been resolved and the materials purchased and incorporated into the structure. At the payment stage preambles may be said to serve a passive role.

The locational information is seen to be inadequate for the calculation of interim payments. Interim valuations measure and value the actual work produced at regular or specific time intervals. Therefore a subdivision of the work which could relate to production would clearly assist this process.

The measured quantities of work are seen to be inappropriate for the purpose of payments where as the units of measurement are quite adequate. The inadequacy of the quantities may reflect the incidence of variations. The general lack of detail in bills, subdividing the quantities into locations, means that any variation, however large or small, will render the quantities to which it

applies inaccurate as a total statement, thereby undermining the value of the document in the minds of all those who use it.

The unit rates are seen to be adequate for calculating payments between the client and the contractor, and those between the contractor and his sub-contractors and suppliers. It would indeed be a matter of some concern if the unit rates were anything but adequate since the payment procedures simply continue the system introduced at tender to its logical conclusion. It is unlikely that the payment procedures will exert any dynamic influence upon the industry to modify or reorganise its tendering or measurement procedures even if such a modification were required.

Reference to Figure 13 and 17 show that the unit rates are seen to be incomplete to plan the production and for buying purposes. Figure 21 indicates, not that the unit rates are lacking, but rather they are not used in the process of manufacture, distribution and control. When this sequence of inadequacy is linked with the fact that the units of measurement are also seen to be inadequate for tendering, the question must be raised, how do the procedures of price control, i.e. payments, relate to the actual costs incurred? Are the costs of production realistically represented and accounted for? Any significant inadequacy in one system to reflect an observed increase in the other is likely to produce dispute and dissatisfaction.

4.5.3. The Independence of Information

More information is shown (Figure 26) to be independent for a greater number of uses when used for payment purposes than for any other.

There is a clear tendency for information from the bill to be either totally dependent or totally independent when used for tender planning and tender pricing. There is no such trend in the payment procedures, rather there is a greater likelihood of individual areas of the bill providing an independent source of information for one task while being dependent upon other information for another.

This mixture of dependence and independence upon other sources of information within the payments procedure is perhaps partly the effect of introducing changes into the contract, and a reflection of the complexity of trying to relate costs to price.

4.5.4. Conclusions

The format of information given in the bill appears generally well suited to the needs of the payment procedures.

The inadequate items of information which influence the settlement of accounts, other than quantity related and provisional items, are wholly contained in the preliminary section of the bill. The structure and inadequacies of these items of information, which appear to have a cost significance, may well relate to method and

○ = Information Independent
 x = Information Dependent

	← Payments to the Contractor →										← Payments by the Contractor →				
	Package No.	Identify type of Construction Work	Size and Location of Contract	Review Tender Documents	Interim Valuations	Measure Variation Orders	Dayworks	Increased Costs	Domestic Sub-Contractors F/A	Nominated Subs/Suppliers F/A	Invoice received & paid for Matls	Invoice rec'd for Domestic Subs A/C	Measure and agree Domestic Subs A/C	A/C received for Nom Subs/Suppliers	Measure & agree Nom. Subs/Supp. A/C
Project Details	1	x	x		○	○				○	○	○	○	○	
Site and Location	2	x	x	x		x	x		x		○	x	x		
Form of Contract	3	○		○	○	○			x	x		○	x	x	
Times and Phasing	4		○					x	x			x			
Financial Details	5			○	○		○	○	x	○	○	○	○	○	
Statutory Details	6			x											
Facilities and Services	7		x		○	○	○		x	○		x		○	
General Responsibilities	8														
Material Specification	9					○	x	○	○		x		○		
Workmanship	10								○			○			
Handling	11					x	x		○	○		○		○	
Tests and Samples	12						x		○			○			
Locational Information	13				○	○					x				
Quantities	14				x	x		○	x			x	x		
Quantity Units	15				○	○		○	○		x	x	○		
Rates	16				○	○			○			○	○		
Extensions	17				○				○			○	○		
Totals	18				○				○			○	○		
Descriptions	19				○	x			○			○	○		
Description Dimensions	20				○	x			○			○	○		
Provisional Quantities	21				○										
Temporary Work	22			x	x	x									
Demolition	23				x	x			x			x		○	
Nominated Suppliers	24		○		x	x	x			x			x	x	
Nominated Sub-Contractors	25		○		x	x	x						x	x	
Provisional Sums	26						x								
Contingency	27						x								

FIGURE 26

INDEPENDENCE OF INFORMATION USED FOR PAYMENTS

the changing influence of time upon the contract.

The presentation and content of the prime cost and provisional sum section of the bill is seen to be totally lacking for the purpose of controlling payments.

The preamble clauses appear to satisfy the needs of the payment activity. This general satisfaction toward the preambles should not be seen to provide evidence of completeness, or accuracy of description, nor of representing the likely reception from the different processes of contracting. It is concluded that the preambles play a passive, rather than an active role in the settlement of accounts.

The units of measurement and unit rates appear to be a suitable and acceptable means of calculating interim payments and settling final accounts so far as measured items of work are concerned. However, since these unit rates are unused by the procedures of manufacture, distribution and control, and are seen to be inadequate for buying and production planning, it is difficult to comprehend how the single rate, which represents a unit quantity of work fixed in position, has either the flexibility or sensitivity to reflect variations in time, dealt with in planning, changes in the individual components of production other than material, obtained by the buying function, or reflect the result of changes in production method, implemented on site. The doubt does not challenge the appropriateness of representing the unit of work fixed in position inclusive of labour and material, but rather the ability of the unit rate to embrace the effect of time and method.

A comparison of the format, adequacy, and independence of the bill when used for tendering and for payments (Figures 8 and 24) shows a striking similarity, firstly in the spread of information used, and secondly, in the areas of unsuitable format, inadequacy and dependence, although it is clear that the individual totals for tendering and payments are different.

It might be deduced that if the dependence upon other data at the tender stage was solely the result of incomplete description then such a deficiency would be resolved by the time payments were due.

It is also concluded that part of the dependence upon other data evident in the payment procedures is necessitated by the admission of variations during the period of the contract.

One is also led to the conclusion that part of the dependence of the bill upon other data for the preparation of the tender and settlement of accounts stems from inherent problems associated with the reconciliation of price and cost, and thus of product and process.

4.6. The Combined Procedures

The procedures discussed so far in this Chapter under the headings of tendering, production planning, buying, manufacture distribution and control and payments each have an individual response toward the bill of quantities in terms of the information used, the frequency of such use and whether the information used is

seen to be suitable in format and content and independent of other information.

The sequence of construction is an interactive process and the work of different procedures forms part of the whole. For this reason this section sets out to present a combined picture of the manner in which the bill is seen to serve the industry.

4.6.1. Dichotomy Presentation

By reducing the individual totals of use recorded for the different areas of information within tendering, production planning, buying, manufacture distribution and control and payments, Figures 8, 12, 16, 20 and 24, to dichotomy data, i.e. where more than 50% of the use is suitable in format, the use of that information is recorded as suitable. On the few occasions where the total is approximately equally divided between suitable and unsuitable these are recorded as only 50% suitable. Figure 27 shows the summary of the dichotomy data.

A number of clear and distinctive patterns emerge both suitable and unsuitable. The locational details - these appear to be largely unsuitable in presentation, incomplete, and requiring the support of other information when used for production planning, buying and manufacture. The quantities and units of measurement are viewed in much the same way only the criticism is extended also into the tendering period.

	Package No.	FORMAT					ADEQUACY					INDEPENDENCE				
		Tendering	Planning	Buying	Manufacture etc.,	Payments	Tendering	Planning	Buying	Manufacture etc.,	Payments	Tendering	Planning	Buying	Manufacture etc.,	Payments
Project Details	1	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Site and Location	2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Form of Contract	3	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Times and Phasing	4	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Financial Details	5	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Statutory Details	6	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Facilities and Services	7	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
General Responsibilities	8	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Material Specification	9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Workmanship	10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Handling	11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tests and Samples	12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Locational Information	13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Quantities	14	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Quantity Units	15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rates	16		✓	✓			✓	✓			✓	✓	✓		✓	✓
Extensions	17		✓	✓			✓	✓			✓	✓	✓		✓	✓
Totals	18	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Descriptions	19	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Description Dimensions	20	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Provisional Quantities	21	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Temporary Work	22	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓
Demolition	23	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓	✓
Nominated Suppliers	24	✓	✓			✓	✓			✓	✓				✓	✓
Nominated Sub-Contractors	25	✓	✓	✓		✓	✓	✓		✓	✓	✓			✓	✓
Provisional Sums	26	✓	✓			✓	✓			✓	✓				✓	✓
Contingency	27	✓				✓				✓					✓	✓

FIGURE 27
SUMMARY OF DICHOTOMY DATA

The unit rates are also seen to be lacking in presentation, content and independence for the needs of production planning and buying.

By contrast the descriptions of work are seen to be suitable in format and content for every procedure. This is felt to clearly support the concept of descriptions based on work complete and fixed in position.

Figure 27 indicates that the manner of presenting nominated sub-contractors' items, package 25, is considered to be unsuitable, and that the details provided are inadequate, and the information dependent upon the support of other data when used by the procedures of tendering, production planning, buying and payments. Having regard firstly to the proportion of work normally represented by these items, and secondly, their consistent unsuitability and inadequacy irrespective of their use, one must question whether the client, the contractor or even the designer is best served by the continuation of practices which make such provisions necessary.

4.6.2. The Programme of Integrated Tasks

Figure 28 shows a summary of the total use made of the bill as a contract progresses from tender to final account. The programme of tasks, Figures 5 and 6 of Chapter III, shows how the procedures and tasks integrate into the whole activity. As tasks end and new tasks commence, a number of changes in the total use of the bill occur.

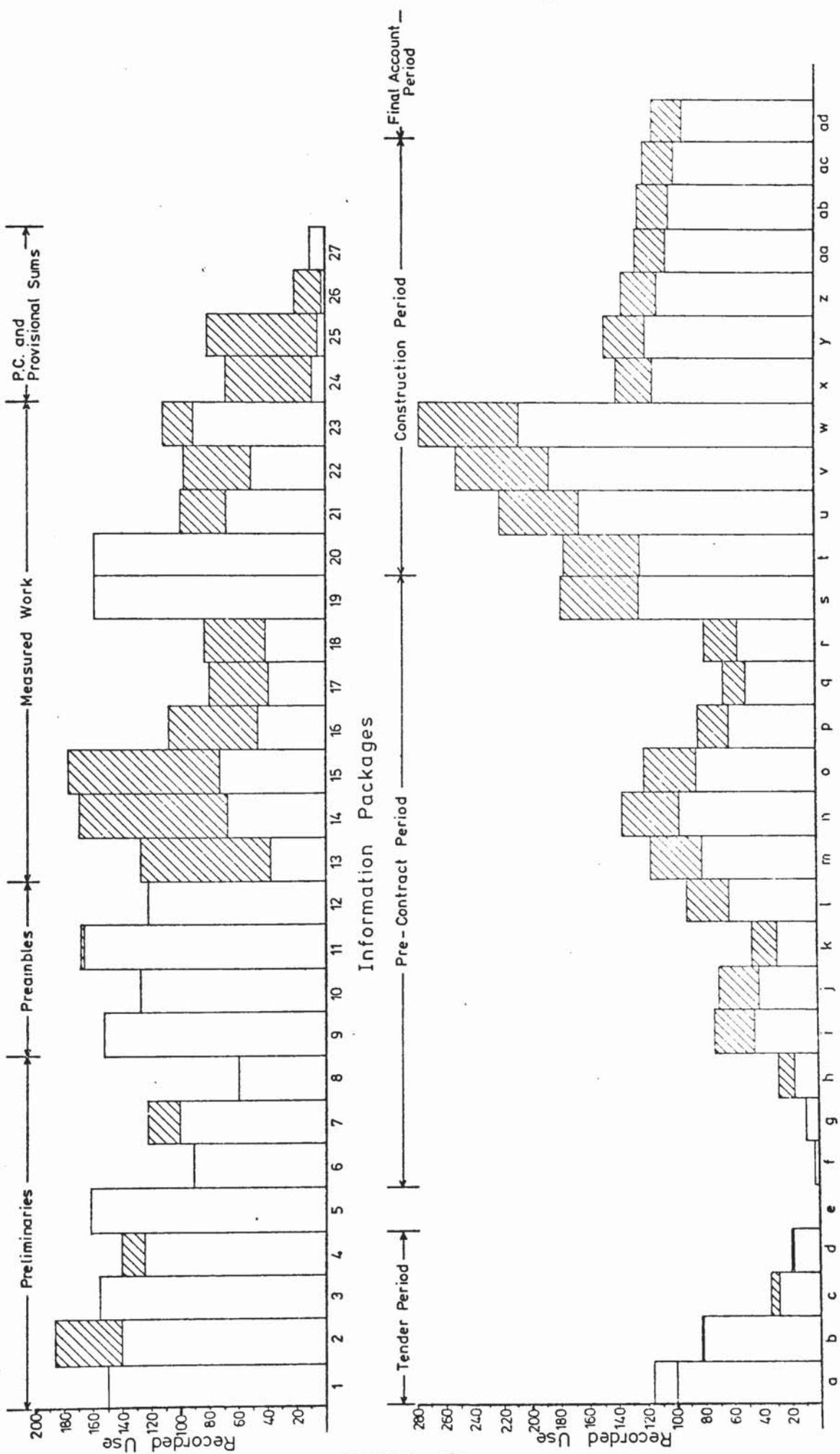


FIGURE 28
INTEGRATED TASKS IN TIME ORDER - FORMAT

These are shown as change points a to ad on Figures 5 and 6 of Chapter III. The use made of the bill at each of these points is totalled and shown in Figure 28.

It is seen in Figure 28 how the use of the bill changes dramatically through the process of time and that most use is made of the bill, not at the tender period as may be supposed, but at a point early in construction. The use made of the bill at this point is approximately two and a half times the largest use recorded during the tender period. It must be added, however, that use at the time of tender is multiplied by the number competing. Subjectively one may expect a high use to be recorded at the tender stage, firstly, because the bill is designed to serve the function of tendering, and secondly, because the tendering activity is contained within the two procedures of tender planning and tender pricing.

At the point of greatest use, point W Figure 28, ten different procedures embracing twenty one different tasks concurrently use the bill, whereas the largest use in the tendering period is made up of seven tasks concurrently using the bill.

Although it is unlikely that any serious thought would be given to modifying any existing procedure of measurement, or presentation of bills of quantities, simply as a result of considering the overall pattern, or magnitude of use made of the bill, it is, however, considered important to the total discussion to indicate the possible cumulative effect which changes to the bill may have.

The suitability of the format, the adequacy and independence of the bill as it serves the contractor throughout the duration of a contract are shown in Figures 28, 29 and 30. The degree of unsuitability is shown shaded.

Two thirds of the criticism made of the format and content of the locational details and units of measurement occur within the procedures of production planning and buying, which on the time scale appear mainly in the pre-contract period. By contrast two thirds of the problems evident with the nominated suppliers' and sub-contractors' items occur within the payments procedure.

It is thus argued that the wide use made of the bill, despite its frequent unsuitability and inadequacy, may be symptomatic of fundamental changes which have taken place within the British building industry over the past forty years.

The importance assumed by technology following the adoption of heavy plant and mechanical equipment, the incidence of new and often synthetic materials and the introduction of scientific thinking and management techniques must have had a significant influence upon the contractors' method, and, in particular, on his dependence upon reliable information.

Following the second world war, the introduction and expansion of the national building programme, the predicted population explosion, the development of new towns, each contributed to cycles of demand at some point of which, an assurance of delivery would become an important aspect of satisfaction. At others, price was the

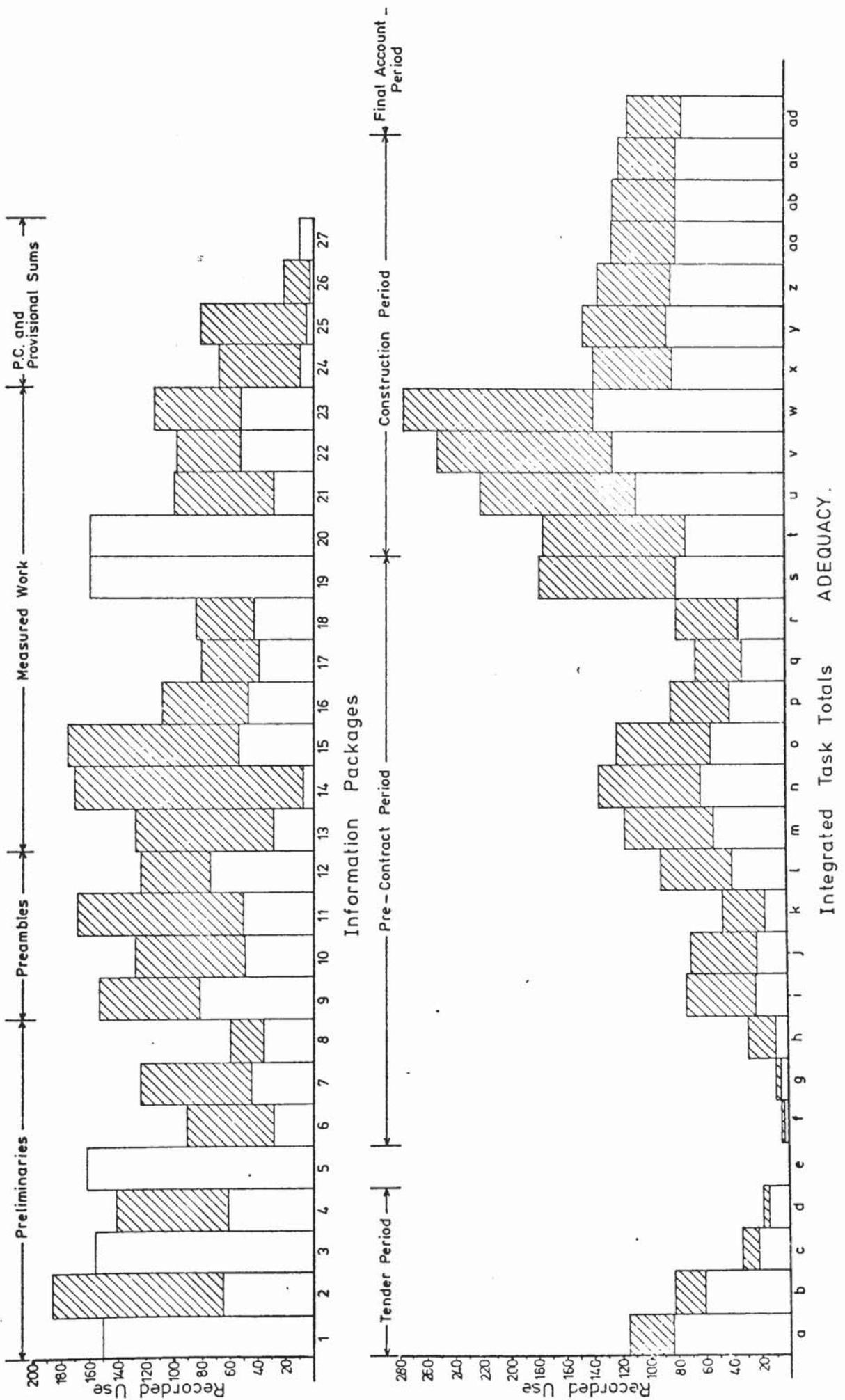


FIGURE 29
 INTEGRATED TASKS IN TIME ORDER - ADEQUACY

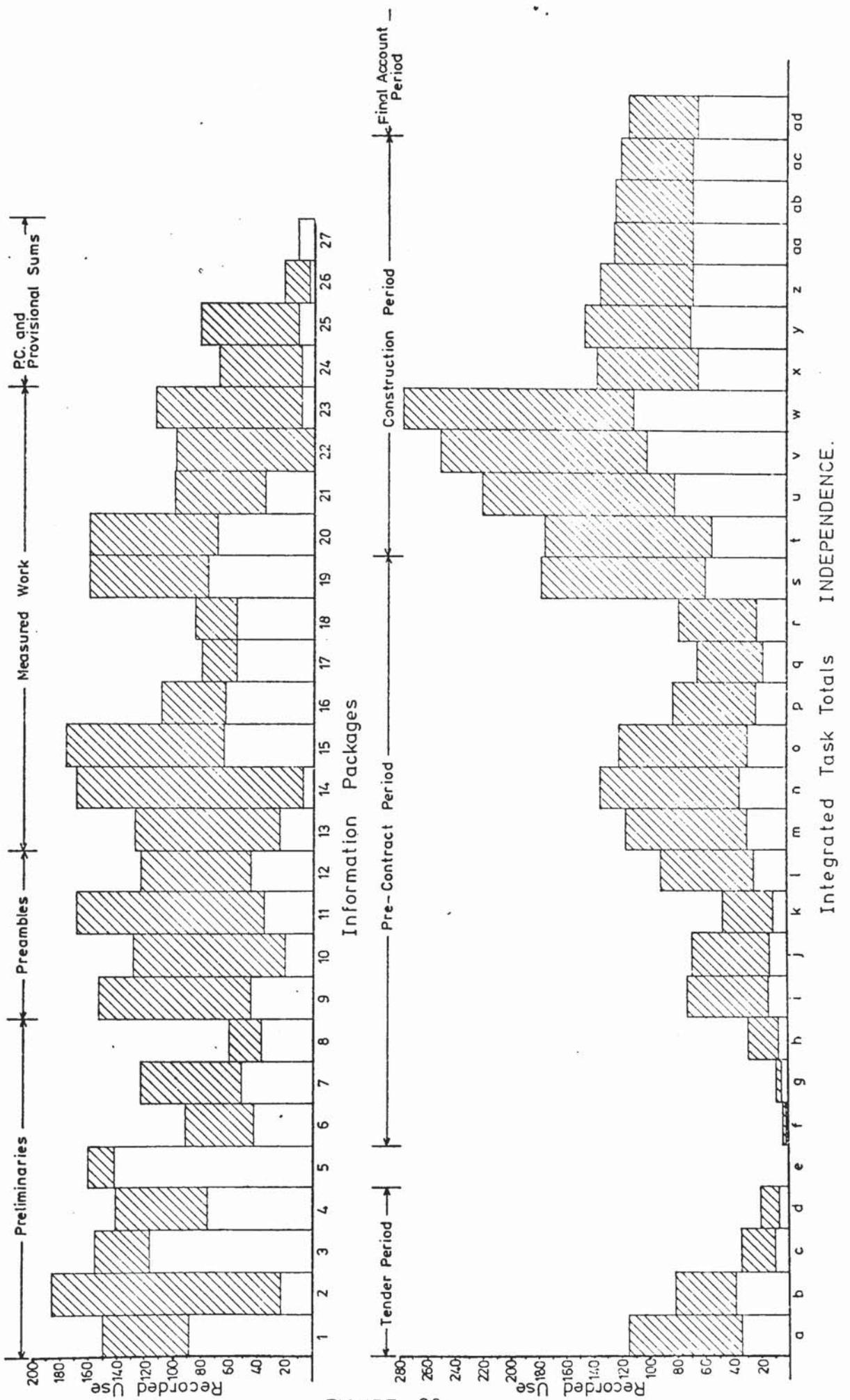


FIGURE 30
INTEGRATED TASKS IN TIME ORDER - INDEPENDENCE

criterion which determined tendering success. In the one case information was needed to improve productivity and make better use of resources, and in others to gain a competitive edge. Few firms have been able to proceed unaffected by such changes of economic climate.

Today the competing contractor must allow in his tender for two aspects, among others, which are of primary concern, time and method.

It is not so much that method was unimportant and time of no significance before the economic and technological changes, but rather they were not the aspects of competition most likely to threaten the viability of the company if disputes could not be quickly and agreeably resolved.

Designers have not, in the main, reflected these changes in their contract documents, with the effect that the building industry has been invested with designers' statements of client requirements which they have had to review and interpret in a multitude of new ways.

The flexibility of the bill in such circumstances is creditable, but strains there must be.

The issue brought into question is that emphasis on the benefit to the client of having a document which provides a common basis for competitive tendering may produce a different document to

one more likely to form a basis for the quality, delivery and price expected by the client of this product. These objectives are not mutually exclusive, on the other hand the evidence is that current bills do not satisfactorily achieve both.

4.6.3. Conclusions

Two thirds of the use where locational information and the quantities are considered to be unsuitable and inadequate, occurs within the pre-contract period. Since the quantities represent much of the substance of the bill, this deficiency occurring before construction actually commences is perhaps an important factor in shaping the general opinion of the industry toward the bill as a whole.

The largest use made of the bill of quantities, despite its inadequacies, occurs outside the tender period. The use observed in the pre-contract and construction periods compared with the tender period leads to the conclusion that a real need exists within contracting for a range of accurate and authoritative information of a quantitative and descriptive nature.

The descriptions of work are regarded by all those who use them, both in tendering and production, as being suitable and adequate for their purpose. One is led to the conclusion that the building industry is not anxious to depart from descriptions of finished construction work in place inclusive of labour and material.

The changes over the past thirty years in economic climate, technology, management techniques, data processing and industrial relations have introduced new competitive criteria into contracting. Existing tender documents have been revised retrospectively and incrementally in the face of experience and pressure. The evidence of this study leads to the view that a penetrating re-evaluation is needed rather than an empirical approach to change.

Next to the prime cost items, the quantities and the units of measurement appear to be the most widely criticised area of information. Although the format of the quantities and the units of measurement are seen to be acceptable to the tendering function they are considered to be inadequate as presented.

The practice of representing work in the form of prime cost sums appears to have little benefit to the client, the contractor or even the designer. The continuing use of prime cost sums on the present scale must be questioned since this research shows that little benefit is gained from the information as provided.

It appears then that the time is ripe to re-examine the critical components of the satisfaction to be gained from a project let by competitive tender, and to see how these should be described and documented in order to assure that they are gained. Whether or not the requirements of tendering and the need for information once the contract is secure may both be satisfied in one document is one matter for review. If they are, then it should be recognised that any change in the presentation or content of bills of quantities

introduced solely to satisfy the needs of tendering are likely to have a far greater effect upon the procedures of production including planning, manufacture, distribution and control than may have previously been supposed.

If the tendering mechanism or the reliability, accuracy, detail or completeness of the information supplied by designers does not directly allow the contractor the opportunity to include all pertinent costs into his tender, or fails to convey with precision the clients requirements, then it is unlikely that design and production will achieve that harmonious blend of effort essential to satisfy the client.

4.7. Matters for Validation

It was considered essential for the completeness of this research that the substance of the major conclusions should be submitted to a larger body of expert opinion within the industry, to ascertain whether or not such conclusions generally found support. The full questionnaire used in the validation study is contained in Appendix D.

The presentation of the items for validation followed the divisions within the principal study of tendering, production planning, buying, manufacture distribution and control and payments.

CHAPTER V

VALIDATION STUDY

C H A P T E R V

VALIDATION STUDY

In the validation study three independent and additional sets of data were obtained, samples A, B and C. Sample A was collected from contractors' quantity surveyors, sample B was collected from specialists in the same companies as the quantity surveyors, and sample C, collected also from specialists who were selected randomly from the national population of contractors registered with the National Federation of Building Trades Employers. Although the responsibility of validating the principal study really lies with the specialists' responses in samples B and C, it was thought useful to discover whether or not there were differing degrees of opinion toward the findings of the principal study as between quantity surveyors and others. The validation study data is contained in Appendix E.

The validation study is composed of four parts, firstly an examination of the questionnaire and the specialists' responses in the two samples B and C, to ascertain whether or not the data collected was influenced in any marked way by the phrasing of the questionnaire. Secondly, an analysis within the sample of quantity surveyors, sample A, and the first group of specialists, sample B, for each question, to examine whether there is agreement between the respondents and also examine whether there is disagreement between groups of respondents.

Thirdly, to compare group response of quantity surveyors with the first sample of specialists for each question. Fourthly, to ascertain an Index of Agreement between quantity surveyors, between quantity surveyors and specialists, sample B, and between the total number of specialists. Also to ascertain a Measure of Agreement between particular samples and the principal study. Finally to ascertain whether the validation data provided from the two samples of specialists supports or refutes the observations from the specialists interviewed in the principal study.

5.1 The Questionnaire and Specialists' Responses

The questionnaire was prepared from the conclusions reached in the principal study. A number of questions (shown *), extra to the principal study, were also included on the questionnaire. Although these questions have not formed part of the exercise to validate the principal study, it was considered useful to have a response from specialists and surveyors on these particular points.

It is possible that the way in which a question is phrased on the questionnaire will significantly influence a respondent's answer. For example, suppose that the principal study leads to the belief that the answer to a particular question would be positive. Then it might also be the case that if the question is phrased in a positive or leading manner the respondent would reply positively, whereas if the question is phrased in a negative manner then the respondent would reply negatively. Clearly it is important to investigate whether or not the question phrasing has a significant effect. This may be done

by ensuring that positive conclusions from the principal study are written as a series of positive and negative questions in the questionnaire and also ensuring that the negative conclusions are written as a series of positive and negative questions.

After obtaining the validation answers the effect of phrasing may then be investigated by drawing up a Threeway Table.

Since the validation is concerned with the sample response to each question, it was considered appropriate to take the sign of the mean response (+ agree, - disagree with the question), see section 5.3.2. below and Sample C Appendix E for mean calculations, to test whether the responses were unduly influenced by the questioning.

The Threeway Table, Figure 31, summarized the response of the first sample of specialists to the questionnaire. It is clearly evident from the fact that only one of the sixty nine table entries lie in cells b, c, f and g that positive conclusions from the principal study were answered positively in the validation exercise, and that negative conclusions from the principal study were also answered negatively, irrespective of whether they were phrased positively or negatively in the validation questionnaire.

The Threeway Table, Figure 32, summarizes the response of the second sample of specialists to the questionnaire. Taking the second sample provided the opportunity to balance the positive and negative phrasing of the questionnaire almost perfectly and make eight paired comparisons of questions 1a and b, 39, 44, 51, 52, 57 and 59. Again

Conclusions Phrasing	PRINCIPAL STUDY			
	+		-	
	Validation Study		Validation Study	
	+	-	+	-
+	a 23	b 1	c 0	d 19
-	e 7	f 0	g 0	h 19
Total	30	1	0	38

FIGURE 31

ANALYSIS OF SPECIALISTS' RESPONSES
 TO PHRASING OF THE QUESTIONNAIRE
 (SAMPLE B)

Conclusions / Phrasing	PRINCIPAL STUDY			
	+		-	
	Validation Study		Validation Study	
	+	-	+	-
	a	b	c	d
+	16	0	0	19
	e	f	g	h
-	15	0	0	19
Total	31	0	0	38

FIGURE 32

ANALYSIS OF SPECIALISTS' RESPONSES
 TO PHRASING OF THE QUESTIONNAIRE
 (SAMPLE C)

the positive conclusions from the principal study were answered positively and the negative conclusions were answered negatively irrespective of whether the questions were phrased in a positive or negative manner on the questionnaire.

The evidence of these two tables is so strong in supporting the null hypothesis that "the respondents are not influenced in any marked way by the phrasing of the questionnaire", that a sophisticated statistical analysis aiming to reject the null hypothesis would be mere pedantry.

5.2 Analysis Within Groups

The two samples examined in this section are the quantity surveyors, sample A, and the first group of specialists, sample B.

The objectives of the tests within this section are:-

- (i) to examine the agreement between respondents
- (ii) to examine the disagreement between groups of respondents for each question in the two sample groups.

Each sample has ten respondents and each respondent has the choice of selecting one of five options as his answer to each question.

5.2.1. Method Used To Test For Agreement Between Respondents

For each question a Null Hypothesis H_0 will be proposed leading to an exact nonparametric significance test.

H_0 : The Null Hypothesis is supported where the respondents' answers show no clustering. Thus the response of any particular respondent may be considered as independent of the answers given by other respondents. Further, the probability that it will be any particular response is equal to $\frac{1}{5}$. Statistically therefore X_i , for $i = 1$ to 10, are independent identical single multinomials with a probability vector $(\frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5})$ and a sample space of $(1, 0, 0, 0, 0)$; $(0, 1, 0, 0, 0)$; $(0, 0, 1, 0, 0)$; $(0, 0, 0, 1, 0)$; $(0, 0, 0, 0, 1)$.

When testing the Null Hypothesis H_0 we will bear in mind the following alternative hypothesis H_1 :-

H_1 : The alternative hypothesis H_1 will be supported when the respondents show strong agreement and their answers tend to cluster in one of the five options, or in two adjacent options. H_1 will also be supported when the respondents tend to group into two opposing clusters, so that one cluster is agreeing with the question, but the other cluster is disagreeing.

A critical region, C , is therefore constructed for the Null Hypothesis, H_0 , such that if the test statistic falls in C , H_0 is rejected in favour of the alternative hypothesis H_1 .

A 95% significance test is adopted. The test statistic is based upon the sufficient statistic $(n_1, n_2, n_3, n_4, n_5)$ where

$$\sum_{i=1}^5 n_i = 10 \quad \text{and } n_i \text{ are the number of respondents answering the question in the } i^{\text{th}} \text{ way.}$$

Let $Y = \text{maximum number } (n_i)$

$Y' = \text{maximum number } (n_i) \text{ but at opposite end of selection options.}$

$Z = \text{maximum number } (n_i + n_{i+1})$

$Z' = \text{maximum number } (n_i + n_{i+1}) \text{ but at opposite end of selection options.}$

Based on the Null Hypothesis H_0 the following exact probabilities are calculated and three rules formulated:

Rule 1

$$\text{Probability } (Y = y \mid y \geq 6) = 5 \binom{10}{y} \left(\frac{1}{5}\right)^y \left(\frac{4}{5}\right)^{10-y}$$

$$\text{Probability } (Y \geq 6) = 0.032$$

On this rule reject H_0 if $y \geq 6$.

Rule 2

$$\text{Probability } (Z = 10, Y = 5) = 4 \binom{10}{5} \left(\frac{1}{5}\right)^{10} = 0.0001$$

$$\text{Probability } (Z = 9, Y = 5) = 4 \times 3 \binom{10}{5} \binom{5}{1} \left(\frac{1}{5}\right)^9 \frac{3}{5} = 0.004$$

$$\text{Total} \quad \quad \quad 0.0041$$

On this rule reject H_0 if $Y = 5$ and $Z \geq 9$.

Rule 3

For disagreeing groups Y must not be in the middle category. Subject to this:-

$$\text{Probability } (Y = 5; Z' = 5) < \binom{4}{1} \binom{10}{5} \left(\frac{1}{5}\right)^5 \left(\frac{2}{5}\right)^5 = 0.0033$$

Now based upon Y being in an extreme category

$$\begin{aligned} \text{Probability } (Y = 4; n_3 = 0; Z' = 5) \\ < 2 \binom{10}{4} \binom{6}{1} \left(\frac{1}{5}\right)^4 \left(\frac{2}{5}\right)^5 \frac{1}{5} = 0.008 \end{aligned}$$

and

$$\begin{aligned} \text{Probability } (Y = 4; n_3 = 0; Z' = 6) \\ < 2 \binom{10}{4} \left(\frac{1}{5}\right)^4 \left(\frac{2}{5}\right)^6 = 0.003 \end{aligned}$$

$$\text{Total} \quad \quad \quad 0.0143$$

On this rule reject H_0 if either,

(i) $Y = 5$, but is not in the middle category and $Z' = 5$,

or

(ii) $Y = 4$ in an extreme location with $n_3 = 0$ and $Z' \geq 5$.

Total probability for the three rules is 0.0504, which correct to three decimal places gives an exact 95% significance test.

5.2.2 Method Used To Test For Disagreement Between Respondents

It is now required to subdivide the critical region C into two areas C_1 and C_2 such that if the test statistic falls in C_2 it may be concluded that the data indicates two opposing groups of opinion and if it belongs to $C_1 = C - C_2$ it may be concluded that the data indicates a single grouping of opinion.

From the three rules in section 5.2.1. we conclude:

If Rule 2 applies then we have C_1 since $Z \geq 9$

If Rule 3 applies then we have C_2 since $Z' \geq 5$ and $Y \geq 4$

If Rule 1 applies with its Y value y . Consider the Null

Hypothesis H_q :

H_q : The probability distribution of the other $10 - y$ people is a Multinomial with probability $(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4})$ over the remaining four classes so that there is no significant opposing group.

We wish to test this hypothesis at the 67% significance level.
 A significant result will be taken to denote two opposing groups and designated C_2 . A non-significant result will denote just one agreeing group and designated C_1

Given Rule 1 was significant with respect to H_0 , then reject H_0 if either:

- (i) $Y' \geq 2$ with Y' in the extreme location
- (ii) $Y = 8; Z' = 2$
- (iii) $Z' \geq 3$

The probabilities for (i) (ii) and (iii) is shown below:

Rule (i)

Probability $(Y' = 4 \mid Y = 6) = \left(\frac{1}{4}\right)^4$	= 0.0039
Probability $(Y' = 3 \mid Y = 6) = 4 \left(\frac{1}{4}\right)^3 \frac{3}{4}$	= 0.047
Probability $(Y' = 2 \mid Y = 6) = \binom{4}{2} \left(\frac{1}{4}\right)^2 \left(\frac{3}{4}\right)^2$	= 0.211
Total	0.2619

Rule (ii)

Probability $(Z' = Z \mid Y = 8) = \left(\frac{1}{2}\right)^2$	0.25
--	------

Rule (iii)

$$\text{Probability } (Z' = 4 \mid Y = 6) = \left(\frac{1}{2}\right)^4 = 0.0625$$

$$\text{Probability } (Z' = 3 \mid Y = 6) = \binom{4}{1} \left(\frac{1}{2}\right)^4 = 0.2500$$

Total 0.3125

5.2.3 Within Group Analysis

It is first required to identify the questions whose responses fall into the critical region C. Next the rules of partitioning are applied to identify the C_1 and C_2 divisions. C_1 indicates one opinion and C_2 indicates two groups of opinion.

Note in Questions 51 to 59 inclusive the specialists are in fact quantity surveyors. For this reason only one set of data, i.e. specialists, has been collected for these questions.

The results are tabulated below:

Question No.	Quantity Surveyors	Specialists (Sample B)
1 a	C ₁	C ₁
b	C ₁	C ₁
2 a	C ₂	C ₁
b	C ₁	C ₁
3 a	C ₁	C ₁
b	C ₁	C ₁
4 a	C ₁	C ₁
b	C ₁	C ₁
5 a	C ₁	C ₁
b	C ₁	C ₁
12 a	C ₂	C ₁
b	C ₁	C ₁
13 a	C ₁	C ₁
b	C ₁	C ₁
14 a	C ₂	C ₁
b	C ₂	C ₁

Question No.	Quantity Surveyors	Specialists (Sample B)
15 a	C ₂	C ₁
b	C ₂	C ₁
16 a	C ₁	C ₁
b	NS	C ₂
17 a	C ₁	C ₁
b	C ₁	C ₁
18 a	C ₁	C ₁
b	C ₁	C ₁
c	C ₁	C ₁
d	C ₁	C ₁
19 a	C ₁	C ₁
b	C ₁	C ₁
c	C ₁	C ₁
20	C ₁	C ₁
21	C ₁	C ₁
22	C ₁	C ₁

Question No.	Quantity Surveyors	Specialists (Sample B)
23	C ₁	C ₁
24	C ₁	C ₁
25	NS	C ₁
26	C ₁	C ₁
27	C ₁	C ₁
28	C ₁	C ₁
29	C ₁	C ₁
30	C ₁	C ₁
31	C ₁	C ₁
32	C ₁	C ₁
33	C ₁	C ₁
34	C ₁	C ₁
35	C ₁	C ₁
36 a	C ₂	C ₁
b	C ₂	C ₁
37	NS	C ₁

Question No.	Quantity Surveyors	Specialists (Sample B)
38	C ₁	C ₁
39	C ₁	C ₁
40	C ₁	C ₁
41	C ₁	C ₁
42	C ₁	C ₁
43	C ₁	C ₁
44	C ₁	C ₁
45	C ₁	C ₁
46	C ₁	C ₁
47	C ₁	C ₁
48	C ₁	C ₁
49	C ₁	C ₁
50	C ₁	C ₁
51		C ₁
52		C ₁
53 a		C ₁

Question No.	Quantity Surveyors	Specialists (Sample B)
53 b		C ₁
54		C ₁
55		C ₂
56		C ₁
57		C ₁
58		C ₁
59		C ₁

A summary of the within group analysis over the 61 validating questions represented by the first 50 statements on the questionnaire is given below.

Q.S. Specialists	C ₁	C ₂	N.S.	Total
C ₁	50	8	2	60
C ₂	0	0	1	1
NS	0	0	0	0
Total	50	8	3	61

C₁ = One body of opinion

C₂ = Two groups of opinion

NS = Not significant, i.e. no clearly defined opinion

The summary clearly shows that in no case do the specialists divide into opposing groups of opinion whenever quantity surveyors are totally agreed.

Specialists were more definite than quantity surveyors in their opinion about the suitability of the bill of quantities for contracting purposes. Out of sixty one questions answered by specialists and quantity surveyors, specialists were statistically of one opinion sixty times, whereas quantity surveyors were agreed only fifty times.

5.3 Analysis Between Groups

The specialists actually use the bill of quantities and are able to respond to questions regarding its suitability, whereas quantity surveyors, except in the procedures dealing with payments made to and made by the contractor, largely conjecture about its suitability when used by specialists.

5.3.1 Method Used To Test For Disagreement Between Specialists and Quantity Surveyors

This section investigates the disagreement between the specialists, sample B, and the quantity surveyors as follows:-

The two groups disagree significantly with each other if the mean score of one group differs in sign from the mean score of the other group and if the difference in the means is statistically significant from zero at the 95% significance level using the sample standard error as estimates.

Let \bar{X}_s and \bar{X}_q be the two means for a particular question, and let their standard errors be

$$\sqrt{\frac{S_s^2}{10}} \quad \text{and} \quad \sqrt{\frac{S_q^2}{10}}$$

Then the difference between the two sample means is

$d = \bar{X}_s - \bar{X}_q$ and its standard error S is given by

$$S^2 = \frac{S_s^2 + S_q^2}{10} \quad \text{based on 9 degrees of freedom.}$$

Since d comprises the 'sum' of 20 observations we can invoke the Central Limit Theorem so that d may be treated as Normally distributed.

The Null hypothesis $H_0 : -\mu = 0$ where μ is the difference between the population means of the specialists and the quantity surveyors.

Under H_0 : the statistic

$$\frac{d - \mu}{s} = \frac{d}{s}$$

has a statistical distribution known and tabulated as Student t based on 9 degrees of freedom.

Scoring: Answers to the questions were ordered and are assumed to be symmetric with respect to agreeable and disagreeable answers. A reasonable metric on the answers appears to be that neighbours are equidistant so the scoring of an answer is taken as follows:-

2 for Agree, 1 for Partially Agree, 0 for Uncertain,
-1 for Partially Disagree, -2 for Disagree.

5.3.2 Analysis of Disagreement Between Specialists and Quantity Surveyors

The results tabulated below show that specialists, Sample B, and quantity surveyors hold a significantly different opinion about the adequacy of information provided in the bill of quantities on eight occasions. Their disagreement relates to questions 12 a and b, 15 a and b, 27, 36 a and b and 42.

Item 12 on the questionnaire states that the quantities are totally adequate for (a) tender planning and (b) tender pricing. As can be seen from the 'Within Group Analysis' on the results above, quantity surveyors were themselves divided in their opinion regarding the adequacy of the quantities when used for tender planning, (12 a). However, comparing the response of the quantity surveyors and specialists, quantity surveyors were inclined to the view that the information was adequate, whereas specialists were of the opposite opinion.

Question	Sample	Score					Mean \bar{X}	Sample Variation s^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
1 a	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
1 b	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
2 a	Q.S.	2	0	1	1	6	0.9	2.8	C ₂	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
2 b	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	8	2	0	0	0	-1.8	0.2	C ₁	
3 a	Q.S.	0	0	0	2	8	1.8	0.2	C ₁	Agree
	Specialists	0	0	0	2	8	1.8	0.2	C ₁	
3 b	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
4 a	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C ₁	
4 b	Q.S.	1	1	0	1	7	1.3	1.9	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	

Question	Sample	Score					Mean \bar{X}	Sample Variation S^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
5 a	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
5 b	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
6 a	Q.S.	3	1	1	0	5	0.3	3.6	NS	Agree
	Specialists	7	0	0	0	3	-0.8	3.7	C ₂	
6 b	Q.S.	1	0	1	0	8	1.4	1.8	C ₁	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
7 a	Q.S.	5	0	0	1	4	-0.1	4.1	C ₂	Agree
	Specialists	3	0	0	1	6	0.7	3.6	C ₂	
7 b	Q.S.	8	0	0	1	1	-1.3	2.2	C ₁	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C ₁	
8	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
9	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	

Question	Sample	Score					Mean \bar{X}	Sample Variation S^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
10	Q.S.	4	0	0	1	5	0.3	4.0	C_2	Agree
	Specialists	1	0	1	0	8	1.4	1.8	C_1	
11	Q.S.	5	1	0	0	4	-0.3	4.0	C_2	Agree
	Specialists	8	0	1	0	1	-1.4	1.8	C_1	
12 a	Q.S.	3	1	0	2	4	0.33	3.3	C_2	*
	Specialists	8	2	0	0	0	-1.8	0.2	C_1	
12 b	Q.S.	1	0	0	1	8	1.3	2.2	C_1	*
	Specialists	8	2	0	0	0	-1.8	0.2	C_1	
13 a	Q.S.	10	0	0	0	0	-2	0	C_1	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C_1	
13 b	Q.S.	9	0	1	0	0	-1.8	0.4	C_1	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C_1	
14 a	Q.S.	3	0	0	0	7	0.8	3.7	C_2	Agree
	Specialists	0	0	0	2	8	1.8	0.2	C_1	
14 b	Q.S.	5	0	0	0	5	0	4.4	C_2	Agree
	Specialists	7	0	2	0	1	-1.2	2.0	C_1	

Question	Sample	Score					Mean — X	Sample Variation S ²	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
15 a	Q.S.	7	0	0	0	3	-0.8	3.7	C ₂	*
	Specialists	0	0	0	3	7	1.7	0.23	C ₁	
15 b	Q.S.	5	0	0	2	3	-0.2	3.7	C ₂	*
	Specialists	0	0	0	2	8	1.8	0.2	C ₁	
16 a	Q.S.	9	0	0	1	0	-1.7	0.9	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
16 b	Q.S.	2	0	1	2	5	0.8	2.6	NS	Agree
	Specialists	3	2	0	5	0	-0.3	2.0	C ₂	
17 a	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
17 b	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	1	0	0	0	9	1.6	1.6	C ₁	
18 a	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
18 b	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	

Question	Sample	Score					Mean \bar{X}	Sample Variation S^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
18 c	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
18 d	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
19 a	Q.S.	9	1	0	0	0	-1.9	0.1	C ₁	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C ₁	
19 b	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
19 c	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	
20	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
21	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
22	Q.S.	9	0	1	0	0	-1.8	0.4	C ₁	Agree
	Specialists	10	0	0	0	0	-2	0	C ₁	

Question	Sample	Score					Mean — X	Sample Variation σ^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
23	Q.S.	1	0	0	3	6	1.3	1.6	C ₁	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
24	Q.S.	9	0	1	0	0	-1.8	0.4	C ₁	Agree
	Specialists	6	3	0	1	0	-1.4	0.93	C ₁	
25	Q.S.	0	1	1	3	5	1.4	1.4	NS	Agree
	Specialists	0	1	0	2	7	1.5	0.93	C ₁	
26	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	2	8	1.8	0.2	C ₁	
27	Q.S.	6	4	0	0	0	-1.6	0.27	C ₁	*
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
28	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
29	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C ₁	
30	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	9	1	0	0	0	-1.9	0.1	C ₁	

Question	Sample	Score					Mean \bar{X}	Sample Variation S^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
31	Q.S.	0	0	0	1	9	1.9	0.1	C_1	Agree
	Specialists	0	0	0	0	10	2	0	C_1	
32	Q.S.	0	0	0	1	9	1.9	0.1	C_1	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C_1	
33	Q.S.	10	0	0	0	0	-2	0	C_1	Agree
	Specialists	8	2	0	0	0	-1.8	0.2	C_1	
34	Q.S.	10	0	0	0	0	-2	0	C_1	Agree
	Specialists	10	0	0	0	0	-2	0	C_1	
35	Q.S.	0	0	0	0	10	2	0	C_1	Agree
	Specialists	0	0	0	0	10	2	0	C_1	
36 a	Q.S.	3	1	0	0	6	0.5	3.7	C_2	*
	Specialists	3	6	1	0	0	-1.2	0.9	C_1	
36 b	Q.S.	3	1	0	0	6	0.5	3.7	C_2	*
	Specialists	4	5	1	0	0	-1.3	0.5	C_1	
37	Q.S.	2	0	0	3	5	0.9	2.5	NS	Agree
	Specialists	0	0	0	3	7	1.7	0.23	C_1	

Question	Sample	Score					Mean X	Sample Variation σ^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
38	Q.S.	10	0	0	0	0	-2	0	C ₁	Agree
	Specialists	6	4	0	0	0	-1.6	0.27	C ₁	
39	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
40	Q.S.	0	1	0	4	5	1.3	0.9	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
41	Q.S.	0	0	0	1	9	1.9	0.1	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
42	Q.S.	10	0	0	0	0	-2	0	C ₁	*
	Specialists	0	0	0	0	10	2	0	C ₁	
43	Q.S.	1	0	0	1	8	1.3	2.2	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
44	Q.S.	0	0	0	0	10	2	0	C ₁	Agree
	Specialists	0	0	0	0	10	2	0	C ₁	
45	Q.S.	0	0	0	4	6	1.6	0.27	C ₁	Agree
	Specialists	0	0	1	1	8	1.7	0.45	C ₁	

Question	Sample	Score					Mean \bar{X}	Sample Variation S^2	Within Group Analysis	Between Group Analysis Indicates * Sig. Disagreement
		-2	-1	0	1	2				
46	Q.S.	0	0	0	1	9	1.9	0.1	C_1	Agree
	Specialists	0	0	0	0	10	2	0	C_1	
47	Q.S.	0	0	0	4	6	1.6	0.27	C_1	Agree
	Specialists	0	0	0	3	7	1.7	0.23	C_1	
48	Q.S.	1	0	0	4	5	1.2	1.5	C_1	Agree
	Specialists	1	0	0	0	9	1.6	1.6	C_1	
49	Q.S.	0	0	0	1	9	1.9	0.1	C_1	Agree
	Specialists	0	0	0	2	8	1.8	0.2	C_1	
50	Q.S.	0	0	0	4	6	1.6	0.27	C_1	Agree
	Specialists	0	0	0	1	9	1.9	0.1	C_1	

In the case of the adequacy of the quantities for tender pricing a clear difference of opinion exists between surveyors and specialists. Quantity surveyors hold the view that the quantities are adequate, but the estimators hold the reverse opinion that the quantities provided in the bill are inadequate for pricing purposes.

The principal study concluded that the quantities were inadequate for tender planning and tender pricing, a view supported by estimators and planners in the validation. The divergence of opinion between specialists and surveyors, and that of quantity surveyors with the principal study may well be of fundamental importance, since the one group, of similar training and qualification to those who prepare the bill, believe the information to be sufficient, whereas the second group, those who actually use the information for pricing purposes, confirm its inadequacy.

Item 15 on the questionnaire states that the preamble clauses describing the handling and placing of materials and components is normally inadequate for (a) tender planning, and (b) tender pricing. Again from the 'Within Group Analysis' it is seen that quantity surveyors were divided in their opinion on both occasions. However, a significant difference of opinion still exists between the two groups.

In this case the principal study concluded, that the preamble clauses describing the handling and placing of materials were inadequate for tender planning and tender pricing. A view supported by estimators and planners, but unsupported by quantity surveyors.

Item 27 on the questionnaire states that the information provided in the preambles is inadequate for planning. The principal study concluded that the preambles were inadequate for the requirement of production planning. Production planners clearly support this conclusion, but quantity surveyors are of the opposite opinion.

Item 36 on the questionnaire states that the information provided in the bill about the site, its location and accessibility is normally adequate for buying (a) materials and (b) plant.

The quantity surveyors, although they were divided in their opinion, were inclined to the view that the information provided in the bill was adequate, whereas those responsible for buying materials and plant were undivided in their opinion that the information was inadequate, a view which supported the conclusion reached in the principal study.

Item 42 on the questionnaire states that the information given in the bill for nominated items is inadequate for buying. On this occasion this is absolute polarity of opinion. Those responsible for securing the services of nominated sub-contractors and the materials and goods from nominated suppliers support the conclusion reached in the principal study, namely that the information is inadequate. Quantity surveyors on the other hand were unanimous in their view that the information provided in the bill was quite adequate.

On each of the eight occasions where a significant difference of opinion is observed, the quantity surveyors disagreed with the conclusions reached in the principal study, while specialists supported them.

It is perhaps also significant that on each of these eight occasions the information provided was regarded by the surveyors to be adequate for the purpose, when all others thought it to be inadequate. This difference of opinion may well demonstrate a need, on the part of quantity surveyors, for greater understanding of the information requirements of the specialists within contracting.

5.4 Validation Of Principal Study

5.4.1 Analysis of the Two Specialists Samples

The responses from the specialists in the two samples B and C are re-arranged to demonstrate their agreement or disagreement with the conclusions reached in the principal study.

'Agree' on the following table indicates agreement with the principal study. Note: questions 6 to 11 inclusive and 54 and 55 are omitted here since these questions were additional to the principal study. The following table shows the specialists' responses to each question; the mean, based upon the scores 2 to -2 discussed in section 5.3; whether the specialists' opinion was united or divided in each sample, here the C_1 and C_2 notation discussed in section 5.2

is used; and finally whether the two samples of specialists are agreed or disagreed.

The table shows that it is rare for the specialists of either sample to be divided in their opinion. Sample B is divided only once, question 16 b, and Sample C is divided twice, questions 12 a and b.

The results of the specialists' responses show clearly that the two samples were only once significantly divided in their opinion, (16 b), regarding the suitability of information provided in the bill of quantities. This question relates to the adequacy of information provided in prime cost items for the activity of tender pricing.

On every other occasion, using the statistical test discussed in section 5.2, the two samples are shown to be of the same opinion which is also that reached in the principal study.

5.4.2 Index and Measure of Agreement

The three samples considered in the validation study are:

Sample A	Quantity surveyors
B	Specialists
C	Specialists

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean \bar{x}	Within Group Analysis	Between Group Analysis
1 a	B	0	0	0	0	10	2	C ₁	Agree
	C	1	0	0	1	8	1.5	C ₁	
1 b	B	0	0	0	0	10	2	C ₁	Agree
	C	1	0	0	1	8	1.5	C ₁	
2 a	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
2 b	B	0	0	0	2	8	1.8	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
3 a	B	0	0	0	2	8	1.8	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
3 b	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
4 a	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
4 b	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
5 a	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean \bar{X}	Within Group Analysis	Between Group Analysis
5 b	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
12 a	B	0	0	0	2	8	1.8	C ₁	Agree
	C	2	1	0	0	7	0.9	C ₂	
12 b	B	0	0	0	2	8	1.8	C ₁	Agree
	C	2	1	0	1	6	0.8	C ₂	
13 a	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
13 b	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
14 a	B	0	0	0	2	8	1.8	C ₁	Agree
	C	1	0	0	2	7	1.4	C ₁	
14 b	B	1	0	2	0	7	1.2	C ₁	Agree
	C	1	0	0	1	8	1.5	C ₁	
15 a	B	0	0	0	3	7	1.7	C ₁	Agree
	C	1	0	0	0	9	1.6	C ₁	
15 b	B	0	0	0	2	8	1.8	C ₁	Agree
	C	1	0	0	0	9	1.6	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean \bar{X}	Within Group Analysis	Between Group Analysis
16 a	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
16 b	B	3	2	0	5	0	-0.3	C ₂	* Disagree
	C	0	0	1	0	9	1.8	C ₁	
17 a	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
17 b	B	1	0	0	0	9	1.6	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
18 a	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
18 b	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
18 c	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
18 d	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
19 a	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean — X	Within Group Analysis	Between Group Analysis
19 b	B	0	0	0	1	9	1.9	C ₁	Agree
	C	1	0	0	0	9	1.6	C ₁	
19 c	B	0	0	0	0	10	2	C ₁	Agree
	C	1	0	0	0	9	1.6	C ₁	
20	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	1	0	9	1.8	C ₁	
21	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
22	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
23	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
24	B	0	1	0	3	6	1.4	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
25	B	0	1	0	2	7	1.5	C ₁	Agree
	C	1	0	0	2	7	1.4	C ₁	
26	B	0	0	0	2	8	1.8	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean \bar{X}	Within Group Analysis	Between Group Analysis
27	B	0	0	0	1	9	1.9	C ₁	Agree
	C	1	0	1	0	8	1.4	C ₁	
28	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
29	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
30	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
31	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
32	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
33	B	0	0	0	2	8	1.8	C ₁	Agree
	C	0	0	0	2	8	1.8	C ₁	
34	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
35	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean - X	Within Group Analysis	Between Group Analysis
36 a	B	0	0	1	6	3	1.2	C ₁	Agree
	C	1	0	0	3	6	1.3	C ₁	
36 b	B	0	0	1	5	4	1.3	C ₁	Agree
	C	1	0	0	3	6	1.3	C ₁	
37	B	0	0	0	3	7	1.7	C ₁	Agree
	C	0	1	0	0	9	1.7	C ₁	
38	B	0	0	0	4	6	1.6	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
39	B	0	0	0	0	10	2	C ₁	Agree
	C	1	0	0	0	9	1.6	C ₁	
40	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
41	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
42	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
43	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean - x	Within Group Analysis	Between Group Analysis
44	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
45	B	0	0	1	1	8	1.7	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
46	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	2	8	1.8	C ₁	
47	B	0	0	0	3	7	1.7	C ₁	Agree
	C	0	0	2	0	8	1.6	C ₁	
48	B	1	0	0	0	9	1.6	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
49	B	0	0	0	2	8	1.8	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
50	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
51	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
52	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	

Question	Sample	-2 Disagree	-1 Partially Disagree	0 Uncertain	1 Partially Agree	2 Agree	Mean \bar{X}	Within Group Analysis	Between Group Analysis
53 a	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
53 b	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	0	10	2	C ₁	
56	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
57	B	0	0	0	1	9	1.9	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	
58	B	0	0	0	5	5	1.5	C ₁	Agree
	C	0	0	1	0	9	1.8	C ₁	
59	B	0	0	0	0	10	2	C ₁	Agree
	C	0	0	0	1	9	1.9	C ₁	

For the validation study an Index of Agreement within samples and between samples is calculated for the following:

- (i) Between quantity surveyors
- (ii) Between quantity surveyors and specialists sample B
- (iii) Between the total number of specialists samples B and C.

Also for the validation study a Measure of Agreement between samples and the principal study is calculated for the following:

- (i) Between specialists, sample B, and the principal study.
- (ii) Between specialists, sample C, and the principal study.
- (iii) Between the total number of specialists and the principal study.

For each Index of Agreement and each Measure of Agreement an approximate 95% single sided confidence interval is calculated.

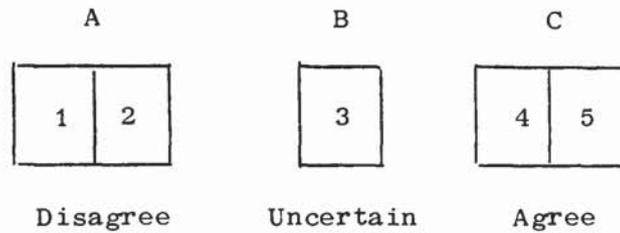
The calculation for the Index of Agreement is based upon the following:

We ask first, if we select a question at random, then select two specialists (or two quantity surveyors) from different companies, what is the probability their answers coincide?

The request that a pair should either agree with the question (strongly or partially), or disagree with the question (strongly or

partially) or not know leads to the following sample probability estimate calculations:

(i) Index of Agreement Between Quantity Surveyors



The sample has ten respondents and sixty nine questions, therefore the number of possible pairs per question is

$$\binom{10}{2} = \frac{10 \times 9}{1 \times 2} = 45 \text{ pairs}$$

let n_A be the number of pairs in A

n_B be the number of pairs in B

n_C be the number of pairs in C

the number of pairs agreeing is $\binom{n_A}{2} + \binom{n_B}{2} + \binom{n_C}{2}$

and the number disagreeing is $45 - \text{the pairs agreeing.}$

$$100 \left[1 - \frac{330}{61 \times 45} \right] = 88 \%$$

Index of Agreement = 88%

The 95% single sided confidence interval is calculated as follows:

$$\begin{array}{l} 95\% \text{ single sided} \\ \text{confidence interval} \end{array} = \hat{P} - 1.65 \hat{\sigma}$$

$$\text{where } \hat{P} = \frac{\text{Number of pairs agreeing}}{\text{Number of possible pairs}}$$

$$\text{and } \hat{\sigma}^2 = p \frac{(1 - \hat{P})}{N}$$

where N = the number of information points

$$\hat{P} = \frac{2415}{2745} = 0.8797$$

$$\hat{\sigma}^2 = \frac{0.8797 (1 - 0.8797)}{61 \times 5} = 0.000347$$

$$\hat{\sigma} = 0.01863$$

$$100 \left[0.8797 - (1.65 \times 0.01863) \right]$$

$$\underline{\text{Confidence Interval}} = \underline{\left[84.9\%, 100\% \right]}$$

This confidence interval is calculated on the basis that there are five independent pairs for each of sixty one independent questions,

giving the equivalent worth of 2745 paired comparisons and worth 305 independent pairs.

(ii) Index of Agreement Between Quantity Surveyors and Specialists (Sample B)

$$100 \left[1 - \frac{957}{6100} \right]$$

Index of Agreement = 84.3%

$$\hat{P} = \frac{5143}{6100} = 0.8431148$$

$$\hat{\sigma}^2 = \frac{0.8431148 (1 - 0.8431148)}{610} = 0.0002168$$

$$\hat{\sigma} = 0.0147255$$

$$100 \left[0.8431148 - (1.65 \times 0.0147255) \right]$$

Confidence Interval = [81.8%, 100%]

The above confidence interval is calculated on the basis that there are ten independent pairs for each of sixty one independent questions, giving the equivalent worth of 11,590 paired comparisons and worth 610 independent pairs.

(iii) Index of Agreement Between the Total Number of
Specialists Samples B and C

$$100 \left[1 - \frac{727}{69 \times 190} \right]$$

Index of Agreement = 94.5%

$$\hat{P} = \frac{12383}{13110} = 0.9445$$

$$\hat{\sigma}^2 = \frac{0.9445 (1 - 0.9445)}{690} = 0.000076$$

$$\hat{\sigma} = 0.008716$$

$$100 \left[0.9445 - (1.65 \times 0.008716) \right]$$

Confidence Interval = [93.1%, 100%]

The above confidence interval is calculated on the basis that there are ten independent pairs for each of sixty nine independent questions, giving the equivalent worth of 13,110 paired comparisons and worth 690 independent pairs.

(i) Measure of Agreement Between Specialists' Responses

Sample B and Principal Study

Summary of specialists' responses, sample B, from section 5.4.1.

Disagree	Partially Disagree	Uncertain	Partially Agree	Agree
3	7	5	69	606

$$\frac{675}{690} \times 100 = 97.83$$

Measure of Agreement = 97.83%

$$\hat{P} = \frac{675}{690} = 0.9783$$

$$\hat{\sigma}^2 = \frac{0.9783 (1 - 0.9783)}{69} = 0.00031$$

$$\hat{\sigma} = 0.01754$$

$$100 \left[0.9783 - (1.65 \times 0.01754) \right]$$

$$\underline{\text{Confidence Interval}} = \left[94.3\%, 100\% \right]$$

The above confidence interval is calculated on the basis that there is one independent pair for each of sixty nine independent

questions, giving the equivalent worth of 690 paired comparisons and worth 69 independent pairs.

(ii) Measure of Agreement Between Specialists' Responses

Sample C and Principal Study

Summary of specialists' responses, sample C, from section 5.4.1.

Disagree	Partially Disagree	Uncertain	Partially Agree	Agree
17	3	6	31	633

$$\frac{664}{690} \times 100 = 96.2$$

Measure of Agreement = 96.2%

$$\hat{P} = \frac{664}{690} = 0.9623$$

$$\hat{\sigma}^2 = \frac{0.9623 (1 - 0.9623)}{69} = 0.0005258$$

$$\hat{\sigma} = 0.0229$$

$$100 \left[0.9623 - (1.65 \times 0.0229) \right]$$

Confidence Interval = [92.4%, 100%]

The above confidence interval is calculated on the basis that there is one independent pair for each of sixty nine independent questions, giving the equivalent worth of 690 paired comparisons and worth 69 independent pairs.

(iii) Measure of Agreement Between the Total Number of Specialists Samples B and C and Principal Study

$$100 \left[\frac{675 + 664}{2 \times 690} \right] = 97.03$$

Measure of Agreement = 97.03%

$$\hat{P} = \frac{1339}{1380} = 0.9703$$

$$\hat{\sigma}^2 = \frac{0.9703 (1 - 0.9703)}{69} = 0.0004177$$

$$\hat{\sigma} = 0.0204$$

$$100 \left[0.9703 - (1.65 \times 0.0204) \right]$$

Confidence Interval = [93.7%, 100%]

The above confidence interval is calculated on the basis that there is one independent pair for each of sixty nine independent

questions, giving the equivalent worth of 1380 paired comparisons and worth 69 independent pairs.

Taking a particular company such as that considered in the principal study, it is to be expected, since all its employees operate within the one company and within the same procedures, that the opinions of specialists within the company will show even more agreement than the opinion of specialists from different types of company using many different procedures.

The Index of Agreement between the total number of specialists sampled is shown to be 94.5% and thus it is not too surprising that unanimous agreement was encountered in the principal study.

5.5 The Additional Questions

It was considered expedient to gain a response from specialists and quantity surveyors on a number of additional matters which were not directly examined in the principal study. Although these items do not form part of the validating process they are reported here for completeness. These were questions 6 - 11 inclusive and 54 and 55.

Questions 6 and 7 relate to the preference of 'trade' and 'elemental' bills for tendering purposes. Both quantity surveyors and specialists are strongly divided (see section 5.3.2 for table of results) in their opinion regarding the suitability of either format for tender planning, although there is a tendency for specialists to

prefer the 'elemental' format. However, for tender pricing, specialists and surveyors are agreed that the 'trade' format is to be preferred.

A similar point was raised in questions 54 and 55, which of the two formats, 'trade' or 'elemental' best suited the work of contractors' quantity surveyors? Although the specialists in the two samples taken were not unanimous in their opinion, the results clearly indicate a preference for a 'trade' format.

Question 8 asked whether a standard presentation and format for bills of quantities would be helpful to tendering. Specialists and quantity surveyors were unanimous in their response that a standard presentation and format would help tendering.

Question 9 questioned whether the Prime Costs and Provisional Sums are best kept in a separate section or bill, rather than interspersing them throughout the document as is evident in some bills. Quantity surveyors and specialists were unanimously agreed that such items should be placed together in one section.

Question 10 and 11 test the opinion of specialists and quantity surveyors on the question of locating trade preambles either in a totally separate section, or placing them immediately in front of the work section to which they relate. It may be anticipated that the response to this question would follow the same response received for 'elemental' and 'trade' format, since in practice the selection of either format will often dictate how trade preambles are arranged.

Quantity surveyors were strongly divided in their opinion as to which method was preferred. Specialists on the other hand were clearly of the opinion that preambles should be placed in one section and not located in front of each work section.

5.6 Conclusions

The two independent validating samples of specialists' opinion, section 5.4.1 and 5.4.2, have individual Measures of Agreement with the principal study of 97.8% and 96.2%. Both these Measures fall well within the confidence interval of the other. The overall Measure of Agreement between all specialists sampled and the principal study is 97%. All three Measures of Agreement endorse the conclusions of the principal study, especially since for each question, their overall group opinion, as measured by their mean response, agrees with that postulated in the light of the principal study.

The two 'Threeway Tables', section 5.1, lead to the positive conclusion that the responses received from the specialists in answer to the questions asked on the questionnaire were not influenced in any marked way by the positive and negative phrasing.

Quantity surveyors and specialists disagree significantly on a number of matters of fundamental importance, section 5.3.2, namely, the adequacy of the quantities and certain preamble clauses when used for tendering purposes. Quantity surveyors consider the information to be adequate, but estimators and planners consider it to be

inadequate. This disagreement must be cause for concern since the principal aim of the bill is to serve as a tendering document.

Quantity surveyors and specialists disagree significantly on eight occasions, section 5.3.2. The nature of the disagreement is disturbing since specialists always concur with the conclusions reached in the principal study, namely that the information is inadequate, but quantity surveyors hold the reverse opinion and conclude the information is adequate for the purpose. This evidence is again reason for concern since those who produce the bill of quantities, being of similar training and qualification to the contractors' quantity surveyors, are unlikely to have any clearer understanding of the contractors' specific information requirements.

The analysis of the sample response of specialists and quantity surveyors, section 5.2.3, shows that out of 61 questions asked, specialists were statistically of one opinion 60 times, whereas quantity surveyors were of one opinion only 50 times. Clearly specialists were more definite than quantity surveyors regarding the suitability of the bill of quantities for the variety of uses in contracting.

CHAPTER VI

CONCLUSIONS

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The substance of the main conclusions reached in the principal study were submitted to two independent samples of specialists for validation. The Measure of Agreement between each sample and the principal study is 97.8% and 96.2%, section 5.4.2. The Measure of Agreement between all specialists sampled and the principal study is 97%. The evidence of the validation study gives unequivocal support to the conclusions of the principal study, especially since for each question their overall group opinion, as measured by their mean response, agrees with that postulated in the light of the principal study.

It is manifest that the bill of quantities contributes to the whole process of building contracting to a greater extent than has previously been acknowledged. To continue to justify the bill simply as a vehicle for contractor selection clearly fails to recognise the potential of its detail, and more particularly, ignores its present extensive contribution to production, which, so far as the successful contractor is concerned, greatly exceeds its contribution to the tendering function. The widespread and continued use of the bill

within the United Kingdom must be attributed to its service to production as well as to the tendering and payment procedures.

The principal reason for the inadequacy of bills of quantities both as a tender document and as an information source to contracting lies in the fact that the requirements of production are not considered. The significant differences of opinion between contractors' surveyors and other specialists, regarding the adequacy of particular areas of information, is in itself an indication that the requirements of production may not be well understood by those who prepare the document. Failure to take account of how the bill is used, and the utility it offers to users other than tenderers and surveyors may also be a consequence of the retrospective and empirical way in which it is reviewed and amended.

The preambles are shown to be suitable for the planning and pricing aspects of tendering. These descriptions of the materials and workmanship standards should, excluding major variation at the outset of the contract, convey to production planning, buying and manufacture an equally precise and authoritative statement of the client's requirements, but this is not the case, they are judged to be inadequate. The fact that quantity surveyors in the validation study, were firmly of the opposite opinion, and considered the information

to be suitable for the needs of production planning, is a matter for concern. This inadequacy, however, raises doubt as to whether essential information was omitted from the tender. Also, if the quality of materials or the standards of workmanship are in any way open to question or interpretation at the tender stage, then the bill cannot be said to have provided tenderers with an equitable common basis. It is evident that the authority of this information deteriorates when the rigour and exactitude of production are applied to it.

The evidence points to a similar conclusion in some areas of preliminary detail. Items considered adequate for tender planning are found to be lacking for the needs of production planning. Equally description, considered to be satisfactory for the needs of estimating is observed to be unsatisfactory when the items of material, labour and plant are actually purchased. How far their description must go to provide an equitable basis for all tenderers is a matter of judgement, but clearly, where information is shown to deteriorate between tender and production when used for very similar purposes, one must question whether the tender lacked essential detail, and whether, in such circumstances, selection is made at the risk of subsequent dispute and claims.

The quantities are the essence of the bill, yet it appears inevitable with present documentation that problems of presentation and content will arise with regard to the quantities when used by procedures of production, since the present concept of measurement is to represent the completed work, i.e. the product, rather than the process. However, since the quantities are also judged by estimators to be inadequate for tendering purposes, one must question whether critical data was omitted from the tender, or whether the judgements which the contractor is left to make with respect to quantities, in any way affects the equity of the information as between tenderers. Despite this, estimators judge the presentation of quantities in their existing format to be suitable, leading one to conclude that the inadequacy relates to some required supplement, rather than a total revision of existing information. Such a supplement may well also answer the criticisms of production. Further, the contractors' quantity surveyors were observed to disagree significantly with estimators regarding the suitability of the quantities for tendering purposes. If such an opinion is also representative of those who prepare the bill, such a disagreement could be of fundamental importance.

The financial detail contained in the bill represents the contractor's model for the project in terms of price to the client. Although the estimator considers and includes in his forecast every aspect of cost, the detail and identity of each individual cost component is lost in the unit rate. This financial detail is shown to be unsuitable in presentation and content for the needs of production planning and buying, and useless for site manufacture and control. The essence of planning is to forecast time and method, while manufacture is concerned to implement both. The critical problems of marrying design and production and relating costs to price are particularly evident here. The utility of this information would be improved if those aspects of cost which relate specifically to time and method could be isolated from those which relate to the fabric of the finished product and shown separately.

The descriptions of work are highly regarded by tendering and production. Both activities consider the information to be suitable in form and content. In this area, the bill achieves a high measure of success.

Prime cost items received the most widespread criticism and raised the most fundamental problems. The method of representing often half of the contract value in these terms must raise serious doubt about such practices. A reliable forecast is based upon accurate description and measurement, both appear to be totally lacking in these items. However, the real dilemma lies in the fact that the contractor has no active involvement with this work, although he is contractually responsible for it, until the architect makes a specific nomination. Such a practice introduces uncertainty and risk, for which financial provision must be made. At the outset of the contract, the production plan cannot be regarded any more reliably in this respect than the tender plan, and buying lacks control over a major area of purchasing. Greater benefit would, however, be derived from this area of the bill if the requirements of production planning, i.e. time periods and construction detail, and buying, i.e. supply and delivery, were incorporated.

The fact that a great many contractors are selected and contracts awarded each year on the basis of bills of quantities should not invoke an attitude of complacency, nor on the other hand, should the mass of published criticism of bills of quantities be cause for despair, but rather, it should be understood that a great potential exists to improve the utility of the information prepared by the quantity surveyor, by recognising the requirements and interaction of all areas of the contracting process.

CHAPTER VII

RECOMMENDATIONS FOR FURTHER WORK

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A study of variations experienced over a wide range of contracts should seek to discover the significance, if any, of time and method in agreeing their settlement. The study should also discover, in cases where quantities are the subject of a claim, how the provisions in the contract for the valuation of items under dispute failed to satisfy the need for value. In the case of claims involving nominated sub-contractors' and suppliers' items, attention should be paid to discovering not only the immediate and obvious cause of the dispute, but also whether the genesis of such problems have any foundation in tender documents.

Prime cost items should be the subject of further study, firstly from the design point of view to determine the state of information normally available within the design office at the time of tendering, relevant to the particular nominated sub-contractors' work and nominated suppliers' items. Secondly it is necessary to discover whether to supply more of that information to the contractor at the time of tendering would in any way be harmful to the final selection, the project, or the client. Thirdly, the study should examine the cost significant factors of incorporating nominated sub-contractors' work and suppliers' items in a contract.

The needs of tender planning in the area of quantified information should be investigated, in order to discover whether requirements may be met from the basic measurements prepared by the quantity surveyor, with appropriate annotation and addition.

Certain areas of the research, particularly nominated sub-contractors' items, locational detail and the provision of site details, should be re-examined in light of the provisions contained in the Sixth Edition of the Standard Method of Measurement of Building Works.

A number of separate studies should be undertaken to investigate how the individual sections of measured work are used and the utility each affords. Such studies should reveal how the measured information in each work section is used, and whether its use is related to the cost significant items. These studies might also show whether the number of items given in the bill may be reduced without serious adverse effect either upon the pricing of the tender or the utility derived by subsequent activities of contracting.

A project might be established to investigate the content and the form of a document which may be used as an alternative to the

current bill in situations where competition is not the method of contractor selection.

Competition should be the subject of further research to reveal the risks and difficulties facing contractors in competition today. In order to evaluate the cost significant factors in a tender and the likely effect upon the contract of changes to any one of them, it is necessary to have access to very considerable quantities of what is usually regarded as confidential information. Only if those offering such information can be persuaded that the benefit would more than cover the risk is there any real prospect of success.

The preamble clauses which define materials, workmanship, handling and placing materials and tests and samples should be examined with specific reference to the requirements of production planning, buying, manufacture, distribution and control, to discover whether or not the inadequacy of these items does react upon the realization on behalf of the client of the expected quality of product.

REFERENCES

R E F E R E N C E S

CHAPTER II

- | | <u>Page</u> |
|--|-------------|
| 1. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Publications 2nd Edition 1965 p.38. | 6 |
| 2. Lee M. ' <u>The Evolution of the Bill of Quantities</u> ' The Chartered Surveyor April 1963 p. 548. | 6 |
| 3. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Publications 2nd Edition 1965 p.38 | 6 |
| 4. Lee M. ' <u>The Evolution of the Bill of Quantities</u> ' the Chartered Surveyor April 1963 p. 548. | 6 |
| 5. Ibid p. 548. | 6 |
| 6. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Publications 2nd Edition 1965 p.38 | 6 |
| 7. Flanagan R. ' <u>A Historical Study of Construction Industry Measurement Practice</u> '. Project in partial fulfilment of Master of Science. University of Aston in Birmingham 1971. p. 14.

Flanagan identifies sixteen books on measurement practice published between 1680 and 1830. | 7 |
| 8. Ibid p. 12. | 7 |

	<u>Page</u>
9. Lee M. <u>'The Evolution of the Bill of Quantities'</u> The Chartered Surveyor April 1963 p. 549	7
10. An Old Builder <u>'Correspondence'</u> to the Architectural Magazine Volume III 1835 p. 359	7
11. Thompson F.M.L. <u>'Chartered Surveyors the Growth of a Profession'</u> Routledge and Keygan Paul 1968 p. 88.	7
12. Ibid p. 89.	8
13. Ibid p. 90.	8
14. Ibid p. 90.	8
15. Lee M. <u>'The Evolution of the Bill of Quantities'</u> The Chartered Surveyor April 1963 p. 548	8
16. Correspondence <u>'The Builder'</u> Competition in Building 1843 Vol. 1 p. 156 Builder's Society 1843 Vol. 1 p. 523 Competition in Building 1844 Vol. II p. 316 Competition 1844 Vol. II p. 329	8
17. Lee M. <u>'The Evolution of the Bill of Quantities'</u> The Chartered Surveyor April 1963 p. 550.	8
18. Nisbet J. <u>'Quantity Surveying in London during the Nineteenth Century'</u> R.I.C.S. Journal Volume XXXI (1951 - 52) p. 522.	8
19. Higgin G. and Jessop N. <u>'Communications in the Building Industry'</u> Tavistock Publications 2nd Edition 1965 p. 42.	8

	<u>Page</u>
20. Lee M. ' <u>The Evolution of the Bill of Quantities</u> ' The Chartered Surveyor April 1963 p. 551.	8
21. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Publications 2nd Edition 1965 p. 41.	8
22. Ibid p. 42.	9
23. Flanagan R. ' <u>A Historical Study of Construction Industry Measurement Practice</u> ' pp. 62 - 65.	9
24. Lee M. ' <u>The Evolution of the Bill of Quantities</u> ' The Chartered Surveyor April 1963 p. 552.	9
25. Ibid p. 552.	9
26. RICS and NFBTE ' <u>Standard Method of Measurement of Building Work</u> ' The Royal Institution of Chartered Surveyors and The National Federation of Building Trades Employers. 5th Edition Metric July 1968.	9
27. Hill I. ' <u>SMM - its past and future</u> ' Building 27 July 1973 p. 98.	9
28. Ibid p. 98.	9
29. Thackray Report ' <u>The Function and Uses of the Bill of Quantities</u> ' The Chartered Surveyor December 1962 p. 321.	10
30. Ibid p. 322.	10

	<u>Page</u>
31. Ibid p. 322	10
32. Seeley I. H. ' <u>Building Quantities Explained</u> ' Macmillan 1972 p. 7.	10
33. Nott C.M. ' <u>Sectionalised Trade Bills</u> ' The Chartered Surveyor May 1963 p. 602	10
34. R.I.C.S. Research Committee Report ' <u>The Use of Elemental Bills of Quantities</u> ' The Chartered Surveyor April 1957	10
35. Nott C.M. ' <u>Sectionalised Trade Bills</u> ' The Chartered Surveyor May 1963 p. 595	10
36. Ibid p. 598	11
37. R.I.C.S. Working Party Report ' <u>The Function and Uses of the Bill of Quantities</u> ' The Chartered Surveyor December 1962 pp. 324 - 325	11
38. Ibid p. 324 - 325	11
39. Ibid p. 324 - 325	11
40. Banwell Sir Harold ' <u>The Placing and Management of Contracts for Building and Civil Engineering Work</u> ' H.M.S.O. 1964 p. 20.	11
41. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Publications. 2nd Edition p. 25.	11

	<u>Page</u>
42. Nisbet J. ' <u>Cost Planning: New Needs and Demands</u> ' Architects Journal February 21 1962.	12
43. R.I.C.S. Working Party Report ' <u>Presentation and Format of Bills of Quantities</u> '. Royal Institution of Chartered Surveyors 1965 p. 3.	12
44. Ibid p. 5.	12
45. R.I.C.S. and N.F.B.T.E. ' <u>The Standard Method of Measurement for Building Works</u> ' The Royal Institution of Chartered Surveyors and National Federation of Building Trades Employers. 5th Edition Metric July 1968 Sections D and E.	12
46. R.I.C.S. Working Party Report ' <u>Presentation and Format of Bills of Quantities</u> ' p. 5.	13
47. Fletcher L. and Moore T. ' <u>Standard Phraseology for Bills of Quantities</u> ' First Edition April 1965	13
48. Potts P.G. Report ' <u>Action on the Banwell Report</u> ' H.M.S.O. 1967 p. 16.	13
49. Ferry D.J.O. and Holes L.G. ' <u>Rationalisation of Measurement</u> ' Research and Information Group of the Quantity Surveying Committee R.I.C.S. 1967.	13
50. Ibid p. 3.	13
51. Potts P.G. Report ' <u>Action on the Banwell Report</u> ' H.M.S.O. 1967 p. 16.	13

	<u>Page</u>
52. Skoyles E.R. <u>'Introduction to Operational Bills'</u> The Quantity Surveyor 1964 Vol 21 (2) p. 27 - 32.	13
53. Ibid	14
54. Skoyles E.R. <u>'Operational Bills and Cost Communication'</u> Building Research Station Current Paper CP/D55.	14
55. Skoyles E.R. <u>'Examples from Operational Bills'</u> Building Research Station E Miscellaneous Papers 9.	14
56. Skoyles E.R. and Fletcher L. <u>'Bills of Quantities or the Operational Bill?'</u> The Architects Journal 28 January 1970 p. 233 - 240.	14
57. Ibid p. 239.	15
58. Skoyles E.R. <u>'The Conventional Bill Criticised'</u> Building Materials May 1970 p. 24.	15
59. Banwell Sir Harold <u>'The Placing and Management of Contracts for Building and Civil Engineering Work'</u> H.M.S.O. 1964.	16
60. Economic Development Committee for Civil Engineering <u>'Contracting in Civil Engineering Since Banwell'</u> H.M.S.O. 1968 p. 1.	16
61. Ibid p. 1.	16
62. Ibid p. 15.	16

	<u>Page</u>
63. Barnes N.M.L. and Thompson P.A. ' <u>Civil Engineering Bills of Quantities</u> ' Construction Industry Research and Information Association Report No. 34. September 1971.	16
64. Barnes N.M.L. ' <u>The Design and Use of Experimental Bills of Quantities for Civil Engineering Contracts</u> ' Thesis presented for Doctor of Philosophy. University of Manchester February 1971.	16
65. Ibid p. 4.1.1. to 4.1.6.	17
66. Barnes N.M.L. and Thompson P.A. ' <u>Civil Engineering Bills of Quantities</u> ' Construction Industry Research and Information Association Report No. 34. September 1971 p. 5.	18
67. I.C.E. ' <u>Civil Engineering Standard Method of Measurement</u> '	18
68. Huges G.A. ' <u>The Civil Engineering Standard Method of Measurement 1976</u> ' The Quantity Surveyor March 1975 p. 127.	18
69. Barnes M. ' <u>Measurement in Contract Control</u> ' Institution of Civil Engineers London 1977. p. 19.	18
70. Higgin G. and Jessop N. ' <u>Communications in the Building Industry</u> ' Tavistock Institute of Human Relations 2nd Edition 1965.	18

	<u>Page</u>
71. Bishop and Alsop K. ' <u>A Study of Coding and Data Co-ordination for the Construction Industry</u> ' Building Research Station and Ministry of Public Buildings and Works February 1969.	19
72. Ibid p. 94.	19
73. Directorate General of Development (Housing and Construction) ' <u>An Information System for the Construction Industry</u> ' Department of the Environment October 1971 p. 35 - 41.	19
74. Directorate General of Development (Housing and Construction) ' <u>Structuring Project Information</u> ' Department of the Environment 1972 p. 30.	19
75. Ibid p. 30.	19
76. Report of the Joint Working Party ' <u>Measurement Conventions</u> '. The Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers 1972.	20
77. Ibid p. 50.	20
78. Standard Method of Measurement Development Unit - ' <u>Interim Report</u> ' The Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers April 1975.	20

	<u>Page</u>
79. Report of the Joint Working Party - ' <u>Measurement Conventions</u> ' The Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers 1972.	20
80. Ibid p. 50.	20
81. Ibid p. 51.	20
82. Hill I. ' <u>S.M.M. - Its Past and Future</u> ' Building 27 July 1973 p. 98.	21
83. Fletcher Professor L. ' <u>S.M.M. - Why we are Changing It</u> ' Building 7th December 1973 p. 122.	21
84. Ibid p. 122.	21
85. Hooker R.J. ' <u>S.M.M. - Why We Are Changing It</u> ' Building 14 December 1973 p. 99.	21
86. Ibid p. 99.	21
87. Bennett J.M. ' <u>S.M.M. - Why We Are Changing It</u> ' Building 14 December 1973 p. 100.	21
88. Hooker R.J. ' <u>S.M.M. - Why We Are Changing It</u> ' Building 14 December 1973 p. 99.	22
89. Bennett J.M. ' <u>The Standard Method of Measurement - Seventh Edition</u> ' The Quantity Surveyor March 1975 p. 188.	22
90. Willis C.J. ' <u>The New Standard Method of Measurement</u> ' Building Technology and Management May 1977 p. 5.	22

	<u>Page</u>
91. Ibid p. 5.	22
92. Ibid p. 6 - 7.	22
93. Banwell Sir Harold ' <u>The Placing and Management of Contracts for Building and Civil Engineering Work</u> ' H.M.S.O. 1964 p. 7.	23
94. Ibid p. 7.	23
95. Ibid p. 10 - 12.	23
96. Potts P.G. ' <u>Action on the Banwell Report</u> ' H.M.S.O. 1967.	23
97. Ibid p. 23.	23
98. Wood Sir Kenneth ' <u>The Public, Client and the Construction Industry</u> ' H.M.S.O. April 1975.	23
99. Ibid p. 73.	23
100. Ibid p. 73.	23
101. The following references are a selection only:-	
(i) Peters J.R. ' <u>The Package Deal and the Alternative</u> ' Building Technology and Management June 1967 p. 3 - 4.	
(ii) Hicks H. ' <u>Management and the Package Deal</u> ' Building Technology and Management January 1968 p. 9 - 11.	24

- (iii) Carter J. 'Package Deals' The Architects
Journal 11, 18, 25 November 1970.
- (iv) Crease D.P. and Turner W.R. 'Alternative
Methods of Contractor Selection - Two
Stage Tendering' The Quantity Surveyor
September 1972 p. 39 - 43.
- (v) Heayes N. 'Taking the Wraps off the
Building Package' Contract Journal April
1976 p. 24 - 25.
- (vi) Hotston F. 'Design and Build - A Money
Saver for local authorities' Building
Trades Journal March 25 1977. pp. 10-14
- (vii) Leader - 'The Stimulus and Challenge of
Design/Build' Building 20 January 1978
p. 39 - 90. 24
102. N.E.D.O. 'The Professions in the Construction Industries'
H.M.S.O. March 1976. 24
103. Ibid p. 17. 24
104. Ibid p. 17. 24
105. Ibid p. 17 - 18. 24
106. Wood Sir Kenneth 'The Public Client and The Construction
Industries' H.M.S.O. April 1975 p. 56. 25

107. (i) Fletcher A.C. 'Multibill' Scottish Special Housing Association Current research.
- (ii) Shanley L.F. and Duffy T. 'The Format of The Bill of Quantities', An Foras Forbartha. Current research.
- (iii) Shanley L.F. 'Changing the Format of the Bill of Quantities'
An Foras Forbartha Current research
Also endorsed by the Royal Institution of Chartered Surveyors.
- (iv) Kennedy W.B. 'The Australian Building Industry Specification' CSIRO Division of Building Research Current research.
- (v) Bromilow F.J. 'Cost Escalation of Building and Construction Works' Division of Building Research Australia. Current research.
- (vi) Williams Eric 'Contract Documentation'
The National Building Agency Current research 25
108. Standing Joint Committee 'Standard Method of Measurement of Building Work' The Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers. 25

109. (i) Smith R.M. 'Information Orientated Bills of Quantities' Heriot-Watt University. Current research.
- (ii) Walker A.; Partridge R.; Shawley F.R.; Jaggar D.M. 'The Need for the possible development of a Communication and Co-ordination System for the U.K. Construction Professions and Industry and Its Role in Project Management. Liverpool Polytechnic. Current research. 25
110. Boyer L.T. and Wolkman R.C. - 'Remote Terminal Cost Estimating' Journal of the Construction Division A.S.C.E. March 1972 p.1. 25
111. Warszawski A. - 'Integrated Contracting Systems' Journal of the Construction Division A.S.C.E. March 1975 p. 213. 25
112. Adrian J.J. - 'Quantitative Methods in Construction Management' Elsevier 1973 p. 33. 25
113. Warszawski A. - 'Integrated Contracting Systems' Journal of the Construction Division A.S.C.E. March 1975 p. 217. 25
114. Adrian J.J. 'Quantitative Methods in Construction Management' Elsevier 1973 p. 35. 25

	<u>Page</u>
115. Heery G.T. ' <u>Time Cost and Architecture</u> ' McGraw-Hill Book Company 1975 p. 127.	26
116. Adrian J.J. - ' <u>Quantitative Methods in Construction Management</u> ' Elsevier 1973 p. 35.	26
117. Higgin G. and Jessop N. - ' <u>Communications in the Building Industry</u> ' The Tavistock Institute of Human Relations 1965 p. 43.	26
118. Committee - ' <u>Model Form of Instructions to Bidders</u> ' Journal of the Construction Division A.S.C.E. March 1974 p. 28.	27
119. Durkee J.L. - ' <u>Needed: U.S. Standard Conditions for Contracting</u> ' Journal of the Construction Division A.S.C.E. June 1977 p. 194.	28
120. Boyer L.T. and Volkman R.C. ' <u>Remote Terminal Cost Estimating</u> ' Journal of the Construction Division A.S.C.E. March 1972 p. 2.	29
121. Adrian J.J. - ' <u>Quantitative Methods in Construction Management</u> ' Elsevier 1973 p. 61.	29
122. Durkee J.L. ' <u>Needed: U.S. Standard Conditions for Contracting</u> ' Journal of the Construction Division A.S.C.E. June 1977 p. 195.	29

	<u>Page</u>
123. Neufville R. de, Heni E.N. and Lesage Y. - ' <u>Bidding Models: Effects of Bidders' Risk Aversion</u> ' Journal of the Construction Division A.S.C.E. March 1977 p. 57.	30
124. Boyer L.T. and Volkman R.C. - ' <u>Remote Terminal Cost Estimating</u> ' Journal of the Construction Division A.S.C.E. March 1972 p. 6.	30
125. Adrian J.J. - ' <u>Quantitative Methods in Construction Management</u> ' Elsevier 1973 pp. 138 - 153.	30
126. The Banwell Report - ' <u>The Placing and Management of Contracts for Building and Civil Engineering Work</u> ' H.M.S.O. 1964.	30
127. Warszawski A. - ' <u>Integrated Contracting Systems</u> ' Journal of the Construction Division A.S.C.E. March 1975 p. 217.	30
128. Byrne W.S. - ' <u>Responsibilities of the Engineer and the Contractor Under Fixed Price Construction Contracts.</u> ' Journal of the Construction Division A.S.C.E. March 1972.	31
129. Borg R.F. - 'Discussion on the Paper by W.S. Byrne <u>'Responsibilities of the Engineer and the Contractor Under Fixed Price Construction Contracts.'</u> Journal of the Construction Division A.S.C.E. July 1973 p. 213.	31

	<u>Page</u>
130. Erikson C.A. and Boyer L.T. ' <u>Estimating - State-of-the-Art.</u> ' Journal of the Construction Division A.S.C.E. September 1976 p. 455.	31
131. Higgin G. and Jessop N. - ' <u>Communications in the Building Industry</u> ' Tavistock Publications 2nd Edition 1965 p. 42.	31
132. Heery G.T. ' <u>Time Cost and Architecture</u> ' McGraw-Hill Book Company 1975 p. 71.	32
133. Walker D.H.T. ' <u>Stipulated sum madness - Canadian tender closing</u> ' Building Technology and Management November 1977 p. 3.	33
134. Davison R.H. ' <u>International Building Cost Comparisons, with special reference to Canada and the United Kingdom</u> ' Project report in partial fulfillment of M.Sc. Degree University of Aston in Birmingham October 1977 p. 78.	33
135. Ibid p. 25.	33
136. Walker D.H.T. ' <u>Stipulated sum madness - Canadian tender closing</u> ' Building Technology and Management November 1977 p. 4.	33
137. Kinlay G. ' <u>The Quantity Surveyor in the Building Industry</u> ' The Building Economist Sept. 1976 p. 79.	35
138. Ibid p. 79	35

	<u>Page</u>
139. Report of a General Council Meeting of the Australian Institute of Quantity Surveyors Building Economist. June 1977 p. 3.	35
140. Bayley D.G. ' <u>Aspects of Quantity Surveying</u> ' The Building Economist June 1977 p. 13.	35
141. Cashman R.F. and Summers D.R. ' <u>Quantity Surveying Practice in Australia</u> ' The Building Economist March 1976 p. 226.	35
142. Kinlay G. ' <u>The Quantity Surveyor in the Building Industry</u> ' The Building Economist Sept. 1976 p. 80.	35
143. (a) Dessewffy Dr. A.G.J. ' <u>In Search of the 'Ideal' Construction Contract</u> ' The Building Economist September 1976 p. 70.	
(b) Chapter W.A. ' <u>The Quantity Surveying Profession</u> ' The Building Economist March 1976 p. 205	36
144. Ibid p. 205.	36
145. Cashman R.F. and Summers D.R. ' <u>Quantity Surveying Practice in Australia</u> ' The Building Economist March 1976 p. 227.	36
146. Ibid p. 227.	36
147. Dessewffy Dr. A.G.J. ' <u>Bills of Quantities for Buildings and Structures of a Civil Engineering Nature in Australia</u> ' The Building Economist March 1975 p. 213.	36

	<u>Page</u>
148. Cashman R.F. and Summers D.R. ' <u>Quantity Surveying Practice in Australia</u> ' The Building Economist March 1976 pp. 226 - 227.	36
149. Chapter W.A. ' <u>The Q.S. Profession</u> ' The Building Economist March 1976 p. 205 - 215.	36
150. Bayley D.G. ' <u>Aspects of Quantity Surveying</u> ' The Building Economist June 1977 p. 13.	36
151. Chapter W.A. ' <u>The Q.S. Profession</u> ' The Building Economist March 1976 p. 206.	36
152. Cashman R.F. and Summers D.R. ' <u>Quantity Surveying Practice in Australia</u> ' The Building Economist March 1976 p. 226.	36
153. Kinlay G. ' <u>The Quantity Surveyor in the Building Industry</u> ' The Building Economist September 1976 p. 79.	36
154. Cashman R.F. and Summers D.R. ' <u>Q.S. Practice in Australia</u> ' The Building Economist March 1976 p. 227.	37
155. Leroux L. ' <u>The History of the Institute of Quantity Surveyors of Australia</u> ' The Building Economist February 1970 p. 120.	37
156. Cashman R.F. and Summers D.R. ' <u>Quantity Surveying Practice in Australia</u> ' The Building Economist March 1976 p. 228.	37

157. Dessewffy Dr. A.G.J. 'Bills of Quantities for Buildings and Structures of a Civil Engineering Nature in Australia' The Building Economist March 1975 p. 213. 38
158. Atkins T.H. 'The Architect's Right of Variation' Project submitted in partial fulfillment of the Degree of Master of Science. University of Aston in Birmingham 1977 p. 10. 38
159. Bromilow F.J. 'The Nature and Extent of Variations to Building Contracts' The Building Economist November 1970 pp. 93 - 118. 38
160. Advertisements for Quantity Surveyors:-
Chartered Surveyor March 1972 p. A 15 A 19 A 22
Chartered Surveyor April 1972 p. A 20 A 24 A 25.
Chartered Surveyor June 1973 p. A 27 A 35.
Chartered Surveyor July 1973 p. A 43 38
161. Cashman R.F. and Summers D.R. 'Quantity Surveying Practice in Australia' The Building Economist March 1976 p. 226. 38
162. Shaw W.T. 'Quantity Surveying - To Bill or Not to Bill?' The Building Economist June 1974 pp. 22 - 25.
Shaw examines the case for measuring Engineering Services widely reported in England between 1970/73. His article is based upon five English reports

162 Dessewffy Dr. A.G.J. 'In Search of the 'Ideal'

Cont. Construction Contract' The Building Economist
2 September 1976 pp. 69 - 78.

Dessewffy here refers to twenty four reports and papers produced in England on the Subjects of Tendering, Contractual Relationships, Measurement and Tendering Documents.

38

163. Dessewffy Dr. A.G.J. 'In Search of the 'Ideal'

Construction Contract' The Building Economist
2nd Sept. 1976 p. 77.

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R E F E R E N C E S

CHAPTER III

	<u>Page</u>
164. The Standard Method of Measurement of Building Works - R.I.C.S. and N.F.B.T.E. 5th Edition Metric July 1968.	46
165. Report of the Joint Working Party - Measurement Conventions - R.I.C.S. and N.F.B.T.E. 1972 p. 49 Section 2.3.1. and 2.3.2.	46
166. <u>'The Standard Method of Measurement of Building Works'</u> R.I.C.S. and N.F.B.T.E. 5th Edition Metric July 1968 Section B pp. 3 - 5.	47
167. Ibid p. 2 Clause A 7.	48
168. Bishop D. and Alsop K. - <u>'A Study of Coding and Data Co-ordination for the Construction Industry'</u> Building Research Station and Ministry of Public Buildings and Works, February 1969 p. 16.	51
169. Ibid p. 7.	52
170. Ibid p. 7.	52
171. Ibid p. 8.	52
172. Directorate General of Development (Housing and Construction) - <u>Structuring Project Information</u> - Department of the Environment, 1972 p. 29.	52

173. Ibid p. 53.

53

B I B L I O G R A P H Y

B I B L I O G R A P H Y

- ADRIAN, J. J. 'Quantitative Methods in Construction Management'
Elsevier 1973.
- ATKINS, T. H. 'The Architect's Right of Variation' M.Sc. University
of Aston in Birmingham, 1977.
- BANWELL, Sir H. 'The Placing and Management of Contracts for Building
and Civil Engineering Work' H.M.S.O. 1964.
- BARNES, M. 'Measurement in Contract Control' I.C.E. London 1977.
- BARNES, N. M. L. 'The Design and Use of Experimental Bills of
Quantities for Civil Engineering Contracts' Ph.D. University
of Manchester, 1971.
- BARNES, N.M.L. and THOMPSON, P. A. 'Civil Engineering Bills of
Quantities C.I.R.I.A. Report No. 34, 1971.
- BAYLEY, D. G. 'Aspects of Quantity Surveying' The Building Economist,
June 1977.
- BENNETT, J. M. 'S.M.M. - Why We Are Changing It' Building,
14 December 1973.

- BENNETT, J. M. 'The Standard Method of Measurement - Seventh Edition' The Quantity Surveyor, March 1975.
- BISHOP, D. and ALSOP, K. 'A Study of Coding and Data Co-ordination for the Construction Industry' Building Research Station and Ministry of Public Buildings and Works, February 1969.
- BORG, R.F. Discussion on the Paper by W. S. Byrne - 'Responsibilities of the Engineer and the Contractor Under Fixed Price Construction Contracts' Journal of the Construction Division A.S.C.E. July 1973.
- BOYER, L. T. and VOLKMAN, R. C. 'Remote Terminal Cost Estimating' Journal of the Construction Division A.S.C.E. March 1972.
- BROMILOW, F. J. 'The Nature and Extent of Variations to Building Contracts' The Building Economist, November 1970.
- BYRNE, W. S. 'Responsibilities of the Engineer and the Contractor Under Fixed Price Construction Contracts' Journal of the Construction Division A.S.C.E. March 1972.
- CARTER, J. 'Package Deals' The Architects Journal, 25 November 1970.
- CASHMAN, R.F. and SUMMERS, D.R. 'Quantity Surveying Practice in Australia' The Building Economist March 1976.
- CHAPTER, W.A. 'The Quantity Surveying Profession' The Building Economist, March 1976.

COMMITTEE - 'Model Form of Instruction to Bidders' Journal of
the Construction Division A.S.C.E. March 1974.

CORRESPONDENCE 'The Architectural Magazine' 1835.

CORRESPONDENCE The Builder 1843, 1844.

CREASE, D. P. and TURNER, W.R. 'Alternative Methods of Contractor
Selection - Two Stage Tendering' The Quantity Surveyor,
September 1972.

DAVISON, R. H. 'International Building Cost Comparisons, with
special reference to Canada and the United Kingdom' M.Sc.
University of Aston in Birmingham, 1977.

DESSEWFFY, A. G. J. 'Bills of Quantities for Buildings and
Structures of a Civil Engineering Nature in Australia'.
The Building Economist, March 1976.

DESSEWFFY, A. G. J. 'In Search of the 'Ideal' Construction Contract'
The Building Economist, September 1976.

DIRECTORATE GENERAL OF DEVELOPMENT (Housing and Construction)
'Structuring Project Information' D.O.E. 1972.

DURKEE, J. L. 'Needed: U.S. Standard Conditions for Contracting'
Journal of the Construction Division A.S.C.E. June 1977.

ECONOMIC DEVELOPMENT COMMITTEE FOR CIVIL ENGINEERING 'Contracting
in Civil Engineering Since Banwell' H.M.S.O. 1968.

ERIKSON, C. A. and BOYER, L. T. 'Estimating - State-of-the-Art'
Journal of the Construction Division A.S.C.E., September
1976.

FERRY, D. J. O. and HOLES, L. G. 'Rationalisation of Measurement'
Research and Information Group of the Quantity Surveying
Committee R.I.C.S. 1967.

FLANAGAN, R. 'A Historical Study of Construction Industry
Measurement Practice' M.Sc. University of Aston, 1971.

FLETCHER, L. 'S.M.M. - Why We Are Changing It' Building 7 December
1973.

FLETCHER, L. and MOORE, T. 'Standard Phraseology for Bills of
Quantities' 1965.

HEAYES, N. 'Taking the Wraps Off the Building Package' Contract
Journal, April 1976.

HEERY, G. T. 'Time Cost and Architecture' McGraw-Hill 1975.

HICKS, H. 'Management and the Package Deal' Building Technology
and Management, January 1968.

HIGGIN, G. and JESSOP, N. 'Communications in the Building Industry'
Tavistock Publications, 2 Ed. 1965.

HILL, I. 'SMM - Its past and future' Building, 27 July 1973.

HOOKER, R. J. 'S.M.M. - Why We Are Changing It' Building 14 December
1973,

HOTSON, F. 'Design and Build - A Money Saver for Local Authorities'
Building Trades Journal, March 25, 1977.

HUGES, G. A. 'The Civil Engineering Standard Method of Measurement
1976' The Quantity Surveyor, March 1975.

I.C.E. 'Civil Engineering Standard Method of Measurement'

KINLAY, G. 'The Quantity Surveyor in the Building Industry' The
Building Economist, September 1976.

LEADER 'The Stimulus and Challenge of Design/Build' Building
20 January 1978.

LEE, M. 'The Evolution of the Bill of Quantities' The Chartered
Surveyor, April 1963.

LEROUX, L. 'The History of the Institute of Quantity Surveyors
In Australia' The Building Economist, February 1970.

N.E.D.O. 'The Professions in the Construction Industries' H.M.S.O.
1976.

NEUFVILLE, R. de, HENI, E. N. and LESAGE, Y. 'Bidding Models:
Effects of Bidders' Risk Aversion' Journal of the
Construction Division A.S.C.E. March 1977.

NISBET, J. 'Cost Planning: New Needs and Demands' Architects
Journal, February 21 1962.

NISBET, J. 'Quantity Surveying in London during the Nineteenth
Century' R.I.C.S. Journal, Vol. XXXI, 1951-2.

NOTT, C. M. 'Sectionalised Trade Bills' The Chartered Surveyor,
May 1963.

PETERS, J. R. 'The Package Deal and the Alternative' Building
Technology and Management, June 1967.

POTTS, P. G. Report 'Action on the Banwell Report' H.M.S.O.
1967.

REPORT of a General Council Meeting of the Australian Institute
of Quantity Surveyors, Building Economist, June 1977.

REPORT of the Joint Working Party 'Measurement Conventions'
R.I.C.S. and N.F.B.T.E. 1972.

R.I.C.S. Research Committee Report 'The Use of Elemental Bills of
Quantities' The Chartered Surveyor, May 1963.

R.I.C.S. Working Party Report 'The Function and Uses of The Bill
of Quantities' The Chartered Surveyor, December 1972.

R.I.C.S. Working Party Report 'Presentation and Format of Bills
of Quantities', 1965.

R.I.C.S. and N.F.B.T.E. 'Standard Method of Measurement of Building
Work' 5th Edition Metric, 1968.

SEELEY, I.H. 'Building Quantities Explained' MacMillan 1972.

SHAW, W.T. 'Quantity Surveying - To Bill or Not to Bill?' The
Building Economist, June 1974.

SKOYLES, E. R. 'The Coventional Bill Criticised' Building Materials,
May 1970.

SKOYLES, E. R. 'Examples from Operational Bills' Building Research
Station E. Miscellaneous Papers 9.

SKOYLES, E. R. 'Introduction to Operational Bills' The Quantity Surveyor, February 1964.

SKOYLES, E. R. 'Operational Bills and Cost Communications' Building Research Station Current paper CP/D55.

SKOYLES, E. R. and FLETCHER, L. 'Bills of Quantities or the Operational Bill?' The Architects Journal, 28 January, 1970.

STANDARD METHOD OF MEASUREMENT DEVELOPMENT UNIT - Interim Report. R.I.C.S. and N.F.B.T.E. April 1975.

STANDING JOINT COMMITTEE 'Standard Method of Measurement of Building Work'. R.I.C.S. and N.F.B.T.E.

THACKRAY REPORT 'The Function and Uses of the Bill of Quantities' The Chartered Surveyor, December 1962.

THOMPSON, F. M. L. 'Chartered Surveyors The Growth of the Profession' Routledge, 1968.

WALKER, D. H. T. 'Stipulated Sum Madness - Canadian tender closing' Building Technology and Management, November 1977.

WARSAWSKI, A. 'Integrated Contracting Systems' Journal of the Construction Division A.S.C.E. March 1975.

WILLIS, C. J. 'The New Standard Method of Measurement' Building
Technology and Management, May 1977.

WOOD, Sir K. 'The Public, Client and the Construction Industry'
H.M.S.O. April 1975.

A P P E N D I X A

DEFINITIONS OF INFORMATION PACKAGES

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1. Project Details

Information relating to the name of the client and the design team, the name of the project and the principal user functions, the number of blocks, structures or sections within the contract, with overall dimensions to each block, structure or section.

2. Site and Location

Information relating to the geographical location of the site, the postal address, the means of access, restrictions relating to the possession of the site, matters concerning adjoining properties, the disposition of new and existing structures, the level of water table, trial hole report and details of existing services and drains.

3. Form of Contract

That set of conditions, terms and clauses, amended in any acceptable manner, which constitute a standard form of agreement between client and contractor.

4. Times and Phasing

Information relating to the possession and completion of the works, details of phasing the completion, agreement on partial completion, and procedures and phasing affecting production.

5. Financial Details

Information relating to liquidated and ascertained damages, the period of interim certificates, the period for honouring certificates, retentions, the type of contract, e.g. fixed price, provision of bond and dayworks.

6. Statutory Details

All matters imposing a statutory obligation to give notices, pay fees, comply with police regulations and the use of explosives.

7. Facilities and Services

All matters relating to the temporary offices, storage accommodation and workshop facilities, temporary toilets, temporary gas, electricity and water, and the location and distribution of existing services, attendance or accomodation, temporary service for drying the works, cleaning the site and work on completion.

8. General Responsibilities

Such matters as the protection of the works, erection, maintenance and removal of hoardings and sign boards and insurances.

9. Material Specification

Information relating to standards and quality of materials used in the work, such as British Standard Specifications, trade literature, and all information relating to mixes and/or strengths where materials are mixed together.

10. Workmanship

Standards and performance of workmen, restrictions imposed upon the speed or method of production, the requirements of curing, drying and protection.

11. Handling and Placing Material

Information relating to the care and protection of materials while being moved from one position to another, such as off-loading, stacking, storing, distributing, lifting and placing in position.

12. Tests and Samples

Those specific items required to satisfy the client or his representative on actual quality and/or consistency of materials

and/or work.

13. Locational Details

Information identifying work with its point of inclusion in the structure such as section, block, level or room.

14. Work Quantities

The total quantity of measured work billed against each description item.

15. Quantity Units

The units in which work quantities are expressed.

16. Unit Rates

The amount of money chargeable for completing one unit of work.

17. Rate Extensions

The product of the unit rate multiplied by the work quantity.

18. Extension Totals

The sum of the rate extensions for each page of the bill of quantities.

19. Work Descriptions

The written statement of the unit of work to be completed.

20. Description Dimensions

Those dimensions included in the work description to define the size of the unit of work.

21. Provisional Quantities

The measurement of work, the nature of which is uncertain in design or extent at the time of tendering, and will be the subject of remeasurement in due course.

22. Temporary Work

Work which must precede the actual building work. It may serve to retain external forces, support the construction work or provide access to the point of working.

23. Demolitions

Pulling down, dismantling and removal of structures existing on the site.

24 and 25 Prime Cost Sums

Sums provided for work or services to be executed by a

nominated sub-contractor, a statutory authority or public undertaking, or for materials or goods to be obtained from a nominated supplier.

26. Provisional Sum

Sums provided for work or for costs which cannot be entirely foreseen, defined or detailed at the time of tendering.

27. Contingency

A sum provided for rectifying any unforeseen eventualities arising either on or off the site and shall not be included initially in respect of any specific item.

A P P E N D I X B

DEFINITIONS OF PROCEDURES

DEFINITIONS OF PROCEDURES

Tender Selection of Projects refers to that process by which a company's general management becomes sufficiently acquainted with the nature of a project to decide whether to tender.

Tender Estimating/Planning refers to the calculation of the number of units of some or all of the resources which will be required to carry out the works, to relate these resources to a time scale, and to those items in the bills to which they contribute costs.

Tender Estimating/Pricing refers to either establishing the cost of any necessary resources and assigning the resultant "costs" to the relevant items in the bill of quantities, or using a unit rate which satisfactorily substitutes for this in order to establish an estimate of the project costs.

Tender/Marketing refers to adjusting the estimated prime cost total to a bid figure which is seen to relate the desirability of being awarded the contract to the benefit likely to be gained.

Production Planning refers to the overall phase and tactical analysis of the work to be executed, the selection of the construction methods to be used and the resources to be employed,

relating the quantities of work, the number of resources and to time within a progressive co-ordinating and economic framework; all described in the programme.

Production Procurement refers to the necessary action to ensure that the required type, number and quality of resources, e.g. data, labour, plant, sub-contractors, materials and capital are actually available at the time required by the programme.

Production Progressing refers to the procurement of resources and the executive action which authorises the expenditure or use of the gathered resources to produce the finished work.

Production Controlling relates plan to performance in production and seeking to regulate progress so as to conform to plan.

Payment to Main Contractor refers to interim and final payments to the main contractor for executed work and materials on site.

Payment by Main Contractor refers to payments made for executed work and materials on site and materials delivered.

A P P E N D I X C

SCHEDULE OF TASKS USING

BILLS OF QUANTITIES

SCHEDULE OF TASKS USING

BILLS OF QUANTITIES

PROCEDURE 1 - TENDER ESTIMATING PLANNING

- (1) Materials and Nominated Suppliers
- (2) Labour
- (3) Plant
- (4) Nominated Sub-Contractors
- (5) Domestic Sub-Contractors
- (6) Project Overheads

PROCEDURE 2 - TENDER ESTIMATING PRICING

- (1) Materials and Nominated Suppliers
- (2) Labour
- (3) Plant
- (4) Nominated Sub-Contractors
- (5) Domestic Sub-Contractors
- (6) Project Overheads
- (7) Establishment Overheads

PROCEDURE 3 - PRODUCTION PLANNING STRATEGIC

- (1) Appoint agent, works manager and general foreman.
- (2) Select engineer and sub-agent
- (3) Select site facilities required e.g. huts and water
- (4) Plan construction method
- (5) Select trade foreman and gangers
- (6) Review contract period and tender details
- (7) Prepare approximate programme and review tender documents
- (8) Examine buying file
- (9) Insurances

PROCEDURE 4 - PRODUCTION PLANNING TACTICAL

- (1) Identify major items of initial construction, select construction method and type of plant used
- (2) Select work for letting to domestic sub-contractors
- (3) Check measure main quantities of work

PROCEDURE 5 - PRODUCTION PROCUREMENT PLANT

- (1) Select plant and prepare method statement of working for larger items
- (2) Procurement of plant

PROCEDURE 6 - PRODUCTION PROCUREMENT MATERIALS

- (1) Measure for material ordering
- (2) Review tender documents and quotations
- (3) Develop enquiry

PROCEDURE 7 - PRODUCTION PROCUREMENT DOMESTIC SUB-CONTRACTORS

- (1) Decision to sub-contract
- (2) Review tender documents and quotations
- (3) Develop enquiry

PROCEDURE 8 - PRODUCTION PROCUREMENT OF NOMINATED SUB-CONTRACTORS
AND SUPPLIERS

- (1) Review tender documents
- (2) Selection of sub-contractor/supplier

PROCEDURE 9 - PRODUCTION PROGRESSING OFF-SITE MANUFACTURE AND
DELIVERY

- (1) Off-site manufacture and delivery

PROCEDURE 10 - PRODUCTION PROGRESSING ON-SITE MANUFACTURE

- (1) On-site manufacture

PROCEDURE 11 - PRODUCTION PROGRESSING ON-SITE DISTRIBUTION

- (1) On-site distribution

PROCEDURE 12 - PRODUCTION CONTROLLING QUALITY

- (1) Controlling quality of materials and workmanship

PROCEDURE 13 - PRODUCTION PAYMENT TO MAIN CONTRACTOR

- (1) Identification of type of construction work
- (2) Consider size and location of contract
- (3) Review tender documents
- (4) Prepare interim valuations
- (5) Remeasure variation orders
- (6) Prepare dayworks
- (7) Calculate increased costs
- (8) Prepare domestic subcontractor's measurement and
final account
- (9) Prepare nominated sub-contractor's measurement and
final account
- (10) Calculate claims

PROCEDURE 14 - PRODUCTION PAYMENT BY MAIN CONTRACTOR

- (1) Invoice received and account paid for materials
- (2) Invoice received and registered for domestic
sub-contractors
- (3) Prepare measure and agree account for domestic
sub-contractors

- (4) Accounts and invoices received for nominated
sub-contractors and suppliers
- (5) Prepare the measurement and agree the accounts
for nominated sub-contractors and suppliers

A P P E N D I X D

VALIDATION QUESTIONNAIRE

VALIDATION QUESTIONNAIRE

TENDERING

The following questions relate to the FORMAT of the information as presented in bills of quantities

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

1. The information in the preliminaries is generally presented in a format suitable for:

(a) tender planning

(b) tender pricing

2. The quantities are unsuitable as presented for:

(a) tender planning

(b) tender pricing

3. The descriptions of work are normally presented in a suitable format for:

(a) tender planning

(b) tender pricing

4. The P.C. and provisional sum information is suitable in format for:

(a) tender planning

(b) tender pricing

5. The format of the preambles is unsuitable for:

(a) tender planning

(b) tender pricing

TENDERING (Contd.)

FORMAT (Contd.)

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

6. A 'trade' bill format is to be preferred for:

(a) tender planning

(b) tender pricing

7. An 'elemental' bill format is to be preferred for:

(a) tender planning

(b) tender pricing

8. A standard presentation and format for bills
would be helpful to the tendering.

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9. P.C. and provisional sums are best kept in a
separate bill or section.

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10. Preambles are best kept in a separate preamble
section.

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11. Preambles are best placed immediately in front of
each work section.

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TENDERING

The following questions relate to the ADEQUACY
(i.e. the amount or quality) of information provided
in the bills of quantities.

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

12. The quantities are totally adequate for:

(a) tender planning

(b) tender pricing

13. The descriptions of measured work are normally

inadequate for:

(a) tender planning

(b) tender pricing

14. Statutory details are normally adequately detailed

in the preliminaries for: (a) tender planning

(b) tender pricing

15. The preamble clauses describing the handling and
 placing of materials and components is normally

inadequate for:

(a) tender planning

(b) tender pricing

16. P.C. items for nominated sub-contractors work is

adequate for:

(a) tender planning

(b) tender pricing

17. The number of cash columns provided in the bill is

insufficient for

(a) tender planning

(b) tender pricing

TENDERING

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

18. The following sections of the bill of quantities
 may be used in tendering without reference to
 any other documents:

- (a) preliminaries
- (b) preambles
- (c) measured work
- (d) P.C. and provisional sums

19. The bill best serves:

- (a) tender planning
- (b) tender pricing
- (c) both activities equally

PRODUCTION PLANNING

The following questions relate to the FORMAT
of information as presented in bills of quantities

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

20. The format of the quantities is unsuitable
for production planning.

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21. The format of descriptions of work is suitable
for planning.

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22. The bill unit rates are used for planning.

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23. The format of information in the preliminaries is
suitable for planning.

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24. The format of the preambles is unsuitable for
production planning.

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PRODUCTION PLANNING

The following questions relate to the ADEQUACY
(i.e. the amount or quality) of information provided
in the bills of quantities

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

25. Generally the information provided in the preliminaries is adequate for planning.

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26. The information provided in the descriptions of work is normally adequate for planning.

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27. The information provided in the preambles is inadequate for planning.

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28. The information provided in the P.C. and provisional sum items is inadequate for planning purposes.

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29. The quantities given in the bill and the units of measurement are inadequate for planning.

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30. The locational information given in the bill is adequate for planning.

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BUYING

The following questions relate to the FORMAT
of information as presented in bills of quantities

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

31. The format of information in the preliminaries
is suitable for buying.

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32. The preamble information is suitable in format
for buying.

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33. The format of locational information is suitable
for buying.

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34. The format of the quantities and the units of
measurement are suitable for buying.

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35. The unit rates included in the bill for the client
are ~~unsuitable~~ suitable for buying purposes.

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BUYING

The following questions relate to the ADEQUACY
(i.e. the amount or quality) of information
provided in the bills of quantities

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

36. The information provided in the bill about the site, its location and accessibility is normally adequate for buying: (a) Materials
(b) Plant

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37. The information provided in the bill regarding statutory obligations is normally inadequate.

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38. The preambles describing the handling and lifting, materials and components is normally adequately detailed in the bill.

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39. The locational information and subdivision of work is inadequate for buying.

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40. The quantities are inadequate for buying materials.

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41. The unit rates in the bill are of little use for buying.

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42. The information given in the bill for nominated items is inadequate for buying.

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BUYING

General Questions

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

43. Generally the information in the bill is not in
a form suitable for buying.

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44. Measured data is essential for buying.

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MANUFACTURE DISTRIBUTION AND CONTROL

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

FORMAT

45. The preambles are suitable in format for
manufacture distribution and control.

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46. The format of descriptions of work is suitable
for manufacture distribution and control.

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47. The format of the quantities is unsuitable.

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ADEQUACY

48. The preambles defining materials and workmanship
are generally inadequate.

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49. The quantities as presented in the bill are
inadequate.

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50. The descriptions of work are normally adequate.

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PAYMENTS

The following questions relate to the FORMAT of the information as presented in bills of quantities.

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

51. The format of information in the measured work section is generally suitable for controlling payments.

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52. The format of the descriptions of work is suitable for the needs of the quantity surveying function.

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53. The format of the P.C. and provisional sum information is suitable for controlling payments:

(a) Made to the contractor

(b) Made by the contractor

54. The 'trade bill' format is the most suitable arrangement for the contractors surveyor.

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55. The 'elemental' format is the most suitable arrangement for the contractors surveyor.

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56. The quantities and descriptions are taken by the contractor to be the clients authoritative statement of the work required at the time of tendering.

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PAYMENTS

The following questions relate to the ADEQUACY
(i.e. the amount or quality) of information
provided in the bills of quantities.

Agree
Partially Agree
Uncertain
Partially Disagree
Disagree

57. The majority of information in the bill is
adequate for controlling payments.

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58. The quantities used for the settlement of
accounts generally vary from those contained
in the bill.

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59. The unit rates contained in the bill are used
extensively in the settlement of accounts.

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A P P E N D I X E

VALIDATION STUDY DATA

VALIDATION STUDY DATA

SAMPLE A

(QUANTITY SURVEYORS)

TENDERING

FORMAT

1 a	1	1	1	2	1	1	1	1	1	1
b	1	1	1	2	1	1	1	1	1	1
2 a	1	1	1	3	2	1	1	1	5	5
b	5	5	5	5	5	5	4	5	5	5
3 a	1	1	1	2	1	1	1	1	2	1
b	1	1	1	1	1	1	1	1	2	1
4 a	5	5	4	5	5	5	5	5	5	5
b	1	2	1	5	1	1	1	4	1	1
5 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	4	5	5	5	5	5	5
* 6 a	5	1	1	3	4	5	1	1	1	5
* b	1	1	1	3	1	5	1	1	1	1
* 7 a	1	5	5	1	2	1	5	5	5	1
* b	5	5	5	2	5	1	5	5	5	5
* 8	1	1	1	1	1	1	1	1	1	1
* 9	1	1	1	1	1	1	1	1	1	1
* 10	5	1	5	2	1	1	1	1	5	5
* 11	1	5	1	4	5	5	5	5	1	1

TENDERING (Contd.)

ADEQUACY

12 a	5	1	1	2	5	2	5	4	1	1
b	1	1	1	2	5	1	1	1	1	1
13 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	3	5	5	5	5	5	5
14 a	1	1	1	5	1	1	1	5	1	5
b	5	5	1	5	1	1	1	5	1	5
15 a	1	5	5	1	5	5	5	1	5	5
b	1	5	5	1	2	5	2	1	5	5
16 a	5	5	5	5	5	5	5	5	2	5
b	1	1	1	5	2	1	2	3	1	5
17 a	1	1	1	1	1	1	1	1	1	1
b	1	1	1	1	1	1	1	1	1	1

GENERAL

18 a	5	4	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	4	5
c	5	5	5	5	5	5	5	5	5	5
d	5	5	5	5	5	5	5	5	5	5
19 a	5	5	5	5	4	5	5	5	5	5
b	1	1	1	1	2	1	1	1	1	1
c	5	5	5	5	5	5	5	5	5	5

PRODUCTION PLANNING

FORMAT

20	1	1	1	1	1	1	1	1	1	1
21	1	1	1	2	1	1	1	1	1	1
22	5	5	5	3	5	5	5	5	5	5
23	1	1	1	2	1	2	2	1	5	1
24	5	5	5	3	5	5	5	5	5	5

ADEQUACY

25	3	1	1	2	1	2	2	4	1	1
26	1	1	1	2	1	1	1	1	1	1
27	4	5	5	4	5	5	5	5	4	4
28	1	1	1	1	1	1	1	1	1	1
29	1	1	1	1	2	1	1	1	1	1
30	5	5	5	5	5	5	5	5	5	5

BUYING

FORMAT

31	1	1	1	1	2	1	1	1	1	1
32	1	1	1	1	2	1	1	1	1	1
33	5	5	5	5	5	5	5	5	5	5
34	5	5	5	5	5	5	5	5	5	5
35	1	1	1	1	1	1	1	1	1	1

ADEQUACY

36 a	5	5	4	1	1	1	1	5	1	1
b	5	5	4	1	1	1	1	5	1	1
37	1	1	1	2	1	5	2	1	5	2
38	5	5	5	5	5	5	5	5	5	5
39	1	1	1	1	1	1	1	1	1	1
40	1	1	1	2	2	1	2	1	4	2
41	1	1	1	1	2	1	1	1	1	1
42	5	5	5	5	5	5	5	5	5	5

GENERAL

43	1	1	1	1	2	1	1	1	5	1
44	1	1	1	1	1	1	1	1	1	1

MANUFACTURE DISTRIBUTION AND CONTROL

FORMAT

45		1	1	1	2	1	2	2	1	2	1
46		1	1	1	2	1	1	1	1	1	1
47		1	1	1	1	1	2	2	2	1	2

ADEQUACY

48		1	5	1	2	1	2	2	1	2	1
49		1	1	1	2	1	1	1	1	1	1
50		1	1	1	2	2	2	2	1	1	1

* Questions extra to the principal study.

VALIDATION STUDY DATA

SAMPLE B

(PARTICULAR SPECIALISTS)

TENDERING

FORMAT

1 a	1	1	1	1	1	1	1	1	1	1
b	1	1	1	1	1	1	1	1	1	1
2 a	2	1	1	1	1	1	1	1	1	1
b	5	5	5	5	5	5	5	5	4	4
3 a	1	1	2	1	1	1	1	1	1	2
b	1	1	1	1	1	1	1	1	1	1
4 a	5	5	5	5	5	5	5	5	5	4
b	1	1	1	1	1	1	1	1	1	1
5 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
* 6 a	5	5	1	5	5	5	5	1	1	5
* b	1	1	1	1	1	2	1	1	1	1
* 7 a	1	1	5	1	2	1	1	5	5	1
* b	5	5	5	5	5	4	5	5	5	5
* 8	1	1	1	1	1	1	1	1	1	1
* 9	1	1	1	1	1	1	1	1	1	1
* 10	5	3	1	1	1	1	1	1	1	1
* 11	1	3	5	5	5	5	5	5	5	5

TENDERING (Contd.)

ADEQUACY

12 a	5	4	5	5	5	5	4	5	5	5
b	4	5	5	5	5	5	5	5	4	5
13 a	5	5	4	5	5	5	5	5	5	5
b	5	5	4	5	5	5	5	5	5	5
14 a	1	1	2	1	1	1	2	1	1	1
b	1	5	5	3	3	5	5	5	5	5
15 a	1	1	1	1	2	2	1	1	1	2
b	1	1	1	1	2	1	1	1	1	2
16 a	5	5	5	5	5	5	5	5	5	5
b	5	5	4	5	2	2	2	2	2	4
17 a	1	1	1	1	1	1	1	1	1	1
b	1	1	1	1	1	1	1	1	1	5

GENERAL

18 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
c	5	5	5	5	5	5	5	5	5	5
d	5	5	5	5	5	5	5	5	5	5
19 a	5	5	5	5	4	5	5	5	5	5
b	1	1	1	1	2	1	1	1	1	1
c	5	5	5	5	5	5	5	5	5	5

PRODUCTION PLANNING

FORMAT

20		1	1	1	1	1	1	1	1	1	1
21		1	1	1	1	1	1	1	1	1	2
22		5	5	5	5	5	5	5	5	5	5
23		1	1	1	1	1	1	1	1	2	1
24		5	5	5	5	4	5	5	4	2	4

ADEQUACY

25		1	1	1	1	2	1	1	2	1	4
26		1	1	1	1	2	1	1	1	2	1
27		1	1	1	1	1	1	1	1	1	2
28		1	1	1	1	1	1	1	1	1	1
29		1	2	1	1	1	1	1	1	1	1
30		5	5	4	5	5	5	5	5	5	5

BUYING

FORMAT

31	1	1	1	1	1	1	1	1	1	1
32	1	1	2	1	1	1	1	1	1	1
33	4	5	5	5	5	5	5	4	5	5
34	5	5	5	5	5	5	5	5	5	5
35	1	1	1	1	1	1	1	1	1	1

ADEQUACY

36 a	4	4	5	4	4	5	5	3	4	4
36 b	4	5	5	4	4	5	5	3	4	4
37	2	1	1	1	1	1	1	1	2	2
38	5	5	5	4	5	4	5	5	4	4
39	1	1	1	1	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1
41	1	1	1	1	1	1	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1

GENERAL

43	1	1	1	1	1	1	1	1	1	1
44	1	1	1	1	1	1	1	1	1	1

MANUFACTURE DISTRIBUTION AND CONTROL

FORMAT

45		1	1	1	1	1	1	2	1	1	3
46		1	1	1	1	1	1	1	1	1	1
47		1	1	1	1	1	1	2	2	1	2

ADEQUACY

48		1	1	5	1	1	1	1	1	1	1
49		1	1	1	1	1	1	2	1	1	2
50		1	1	1	1	1	1	1	1	1	2

PAYMENTS

FORMAT

51	1	1	1	1	1	1	1	1	1	1
52	1	1	1	1	1	1	1	1	1	1
53 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
* 54	1	1	1	2	2	1	1	1	1	5
* 55	5	5	5	2	1	5	5	5	5	1
56	1	1	1	1	1	1	1	1	1	1

ADEQUACY

57	1	1	1	1	1	1	1	1	2	1
58	1	2	2	2	1	2	2	1	1	1
59	1	1	1	1	1	1	1	1	1	1

* Questions extra to the principal study.

VALIDATION STUDY DATA

SAMPLE C

(PARTICULAR SPECIALISTS)

TENDERING

FORMAT

1 a	4	1	5	5	5	5	5	5	5	5
b	4	1	5	5	5	5	5	5	5	5
2 a	1	1	1	1	1	1	1	1	1	1
b	5	5	5	5	5	4	5	5	5	5
3 a	1	1	1	1	1	1	1	2	1	1
b	1	1	1	1	1	1	1	2	1	1
4 a	5	5	5	5	5	5	5	5	5	5
b	1	1	1	1	1	1	1	1	1	2
5 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
* 6 a	5	5	1	5	5	5	1	1	1	5
* b	5	1	1	1	1	1	1	1	1	3
* 7 a	1	1	5	1	1	1	5	5	5	1
* b	1	5	5	5	5	5	5	5	5	3
* 8	1	1	1	1	1	1	1	1	1	1
* 9	1	1	1	1	1	1	1	1	1	1
* 10	1	1	5	5	5	5	1	5	5	5
* 11	1	5	1	1	1	1	5	1	1	1

TENDERING (Contd.)

ADEQUACY

12 a	5	5	5	5	5	5	2	1	1	5
b	5	5	4	5	5	5	2	1	1	5
13 a	5	5	5	5	5	5	4	5	5	5
b	5	5	5	5	5	5	4	5	5	5
14 a	1	1	1	2	2	1	1	1	1	5
b	5	4	5	5	5	5	1	5	5	5
15 a	1	1	1	1	1	1	1	1	1	5
b	1	1	1	1	1	1	1	1	1	5
16 a	5	5	5	5	5	5	5	5	5	5
b	1	3	1	1	1	1	1	1	1	1
17 a	1	1	1	1	1	1	1	1	1	1
b	1	1	1	1	1	1	1	1	1	1

GENERAL

18 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
c	5	5	5	5	5	5	5	5	5	5
d	5	5	5	5	5	5	5	5	5	5
19 a	5	5	5	5	5	5	5	5	5	5
b	1	1	1	1	1	5	1	1	1	1
c	5	5	5	5	5	1	5	5	5	5

PRODUCTION PLANNING

FORMAT

20	1	1	1	1	1	1	3	1	1	1
21	1	1	1	1	1	1	1	1	1	1
22	5	5	5	5	5	5	5	5	5	5
23	1	1	1	1	1	1	1	1	1	1
24	5	5	5	5	5	5	4	5	5	5

ADEQUACY

25	1	2	2	1	1	1	1	1	1	5
26	1	1	1	1	1	1	1	1	1	1
27	1	1	3	1	5	1	1	1	1	1
28	1	1	1	1	1	1	1	1	2	1
29	1	1	1	1	1	1	1	1	1	1
30	5	5	5	5	5	5	5	5	5	5

BUYING

FORMAT

31	1	1	1	1	1	1	1	1	1	1
32	1	1	1	1	1	1	1	1	1	1
33	5	4	5	4	5	5	5	5	5	5
34	5	5	5	5	5	5	5	5	5	5
35	1	1	1	1	1	1	1	1	1	1

ADEQUACY

36 a	5	1	4	4	5	5	4	5	5	5
b	5	1	4	4	5	5	4	5	5	5
37	1	1	4	1	1	1	1	1	1	1
38	5	5	5	5	5	5	5	5	5	5
39	5	1	5	5	5	5	5	5	5	5
40	1	1	1	1	1	1	1	1	1	1
41	1	1	1	1	1	1	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1

GENERAL

43	1	1	1	1	1	1	1	1	1	1
44	5	5	5	5	5	5	5	5	5	5

MANUFACTURE DISTRIBUTION AND CONTROL

FORMAT

45		1	1	1	1	1	1	1	1	1	1
46		1	1	2	1	1	1	1	1	2	1
47		1	1	3	1	1	1	3	1	1	1

ADEQUACY

48		1	1	1	1	1	1	1	1	1	1
49		1	1	1	1	1	1	1	1	1	1
50		1	1	1	1	1	1	1	1	1	1

PAYMENTS

FORMAT

51	5	5	5	5	5	5	5	5	4	5
52	5	5	5	5	5	5	5	5	4	5
53 a	5	5	5	5	5	5	5	5	5	5
b	5	5	5	5	5	5	5	5	5	5
* 54	1	1	1	5	1	1	5	5	5	1
* 55	5	5	5	1	5	5	1	1	1	5
56	1	1	2	1	1	1	1	1	1	1

ADEQUACY

57	5	5	5	5	5	5	5	5	5	4
58	1	1	1	1	1	3	1	1	1	1
59	5	5	5	5	5	5	5	5	5	4

* Questions extra to the principal study.

SAMPLE C (Contd.)

Question	Score					Mean \bar{X}	Sample Variation S^2
	-2	-1	0	1	2		
1 a	8	1	0	0	1	-1.5	2.2
b	8	1	0	0	1	-1.5	2.2
2 a	0	0	0	0	10	2	0
b	9	1	0	0	0	-1.9	0.1
3 a	0	0	0	1	9	1.9	0.1
b	0	0	0	1	9	1.9	0.1
4 a	10	0	0	0	0	-2	0
b	0	0	0	1	9	1.9	0.1
5 a	10	0	0	0	0	-2	0
b	10	0	0	0	0	-2	0
6 a	6	0	0	0	4	-0.4	4.3
b	1	0	1	0	8	1.4	1.8
7 a	4	0	0	0	6	0.4	4.3
b	8	0	1	0	1	-1.4	1.8
8	0	0	0	0	10	2	0
9	0	0	0	0	10	2	0
10	7	0	0	0	3	-0.8	3.7
11	2	0	0	0	8	1.2	2.8
12 a	7	0	0	1	2	-0.9	3.2
b	6	1	0	1	2	-0.8	3.1
13 a	9	1	0	0	0	-1.9	0.1
b	9	1	0	0	0	-1.9	0.1
14 a	1	0	0	2	7	1.4	1.6
b	8	1	0	0	1	-1.5	1.6

SAMPLE C (Contd.)

Question	Score					Mean \bar{X}	Sample Variation S^2
	-2	-1	0	1	2		
15 a	1	0	0	0	9	1.6	1.6
b	1	0	0	0	9	1.6	1.6
16 a	10	0	0	0	0	-2	0
b	0	0	1	0	9	1.8	0.4
17 a	0	0	0	0	10	2	0
b	0	0	0	0	10	2	0
18 a	10	0	0	0	0	-2	0
b	10	0	0	0	0	-2	0
c	10	0	0	0	0	-2	0
d	10	0	0	0	0	-2	0
19 a	10	0	0	0	0	-2	0
b	1	0	0	0	9	1.6	1.6
c	9	0	0	0	1	-1.6	1.6
20	0	0	1	0	9	1.8	0.4
21	0	0	0	0	10	2	0
22	10	0	0	0	0	-2	0
23	0	0	0	0	10	2	0
24	9	1	0	0	0	-1.9	0.1
25	1	0	0	2	7	1.4	1.6
26	0	0	0	0	10	2	0
27	1	0	1	0	8	1.4	1.8
28	0	0	0	1	9	1.9	0.1
29	0	0	0	0	10	2	0

SAMPLE C (Contd.)

Question	Score					Mean \bar{x}	Sample Variation s^2
	-2	-1	0	1	2		
30	10	0	0	0	0	-2	0
31	0	0	0	0	10	2	0
32	0	0	0	0	10	2	0
33	8	2	0	0	0	-1.8	0.2
34	10	0	0	0	0	-2	0
35	0	0	0	0	10	2	0
36 a	6	3	0	0	1	-1.3	1.6
b	6	3	0	0	1	-1.3	1.6
37	0	1	0	0	9	1.7	0.8
38	10	0	0	0	0	-2	0
39	9	0	0	0	1	-1.6	1.6
40	0	0	0	0	10	2	0
41	0	0	0	0	10	2	0
42	0	0	0	0	10	2	0
43	0	0	0	0	10	2	0
44	10	0	0	0	0	-2	0
45	0	0	0	0	10	2	0
46	0	0	0	2	8	1.8	0.2
47	0	0	2	0	8	1.6	0.7
48	0	0	0	0	10	2	0
49	0	0	0	0	10	2	0
50	0	0	0	0	10	2	0
51	9	1	0	0	0	-1.9	0.1

SAMPLE C (Contd.)

Question	Score					Mean \bar{X}	Sample Variation S^2
	-2	-1	0	1	2		
52	9	1	0	0	0	-1.9	0.1
53 a	10	0	0	0	0	-2	0
b	10	0	0	0	0	-2	0
* 54	4	0	0	0	6	0.4	4.3
* 55	6	0	0	0	4	-0.4	4.3
56	0	0	0	1	9	1.9	0.1
57	0	0	0	1	9	1.9	0.1
58	0	0	1	0	9	1.8	0.4
59	9	1	0	0	0	-1.9	0.1

* Questions extra to the principal study.