

This item was submitted to Loughborough University as a PhD thesis by the author and is made available in the Institutional Repository (<u>https://dspace.lboro.ac.uk/</u>) under the following Creative Commons Licence conditions.

COMMONS DEED
Attribution-NonCommercial-NoDerivs 2.5
You are free:
 to copy, distribute, display, and perform the work
Under the following conditions:
Attribution . You must attribute the work in the manner specified by the author or licensor.
Noncommercial. You may not use this work for commercial purposes.
No Derivative Works. You may not alter, transform, or build upon this work.
 For any reuse or distribution, you must make clear to others the license terms of this work
 Any of these conditions can be waived if you get permission from the copyright holder.
Your fair use and other rights are in no way affected by the above.
This is a human-readable summary of the Legal Code (the full license).
<u>Disclaimer</u> 曰

For the full text of this licence, please go to: <u>http://creativecommons.org/licenses/by-nc-nd/2.5/</u>

BLDSC no :- DX 170671





BLDSC no :- DX 170671

あいち ちょうちょうかち ちちい あいっちょう

白紫白にあ

AUTHOR/FILING	TITLE
<u>PA</u>	SQUIRE, CL
ACCESSION/COP	Y NO.
	036000313
VOL. NO.	CLASS MARK
Please note	that fines are charged on ALL overdue items.
a a . a a di sanada .	
2 7 NOV 2000	
••••••••••••••••••••••••••••••••••••••	· · · · · · · · · · · · · · · · · · ·

0360003113

BLDSC DE :- DX 170671



036000313 3

BAOMINTON PRESS 10 THE HALFEROFT SYSTON LETCESTER LEAD TEL: 0-58 622777 FAX 6588 62353

BUILDERS QUANTITIES FOR CONTRACTORS' MANAGEMENT

١.

.

by

C L Pasquire, BSc, ARICS

A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology

1991

© by C L Pasquire 1991

Loughborough University of Technology Library
Date Ang 92
Class
Acc 036000313

.

4

.

.

.

W9920771

LIST OF TABLES

		Page
Table 1.1	Number of small firms in the construction industry	5
Table 3.1	Research programme	13
Table 5.1	Tasks performed by management functions - Case Study A	47
Table 5.2	Tasks performed by management functions - Case Study B	48
Table 5.3	Tasks performed by management functions - Case Study C	49
Table 5.4	Standardization of management tasks and functions	51
Table 7.9	Critical Tasks	100

.

.

•

.

LIST OF FIGURES

_

Figure 7.1	Initial flow of data through contracting organizations	89
Figure 7.2	Data flow between management functions	91
Figure 7.3	Data flow between management tasks	92
Figure 7.4	Data interfaces in estimating management function	94
Figure 7.5	Data interfaces in purchasing management function	95
Figure 7.6	Data interfaces in planning management function	96
Figure 7.7	Data interfaces in surveying management function	97
Figure 7.8	Double interfaces	98
Figure 7.9	Deleted	
Figure 7.10	Improved data flow	103
Figure 8.1	First draft of taking-off sheet	132
Figure 8.2	Second draft of taking-off sheet	135
Figure 8.3	Third draft of taking-off sheet	136
Figure 8.4	Final draft of taking-off sheet	137
Figure 10.1	Wall runs	200
Figure 10.2	Roof compartment	204

•

SYNOPSIS

It was shown that much compensating work was undertaken by personnel of contracting organizations during the management of construction projects when they used measured quantity data prepared by the Clients' Quantity Surveyor. It was further shown that a standard method for preparing measured quantity data which reflected contracting management and construction methods could be developed if the amount and type of compensating work was identified. This method for measuring construction work would consequently find a use in the increasingly popular Design and Construct procurement method resulting from the swing in investment in construction work to the private sector which eroded the existing four-cornered Client: Designer : Quantity Surveyor : Contractor relationship. This swing allowed entreprenurial contracting organizations to by-pass the middle men (Designers and Quantity Surveyors) and liaise directly with the Client, adopting the traditional design team's role in the process. This situation effectively removed the centralised and controlled production of measured quantity data at pre-tender stage (i.e. Bills of Quantities prepared by the Quantity Surveyor) leaving the contractor to prepare his own measured quantity data ad-hoc.

The main objectives included researching within contracting organizations to define the use to which measured quantity data was put within the management functions of estimating, purchasing, surveying, planning and site management. Determining what quantity data should be measured for the benefit of these management functions. Field testing the determined measurement rules with upto three live specification and drawing contracts, in order to show that improvements could be made in the data flow and efficiency of data management. Publishing the findings of the research.

Case studies within three contracting organizations were undertaken and interfaces between and within the management functions where compensating work was undertaken were identified. The measured quantity data required by contracting personnel for management tasks was defined. A set of measurement rules for Builders' Quantities was compiled and tested on five projects, each of which was supplied by a different contractor. Some work was published and more publications were planned at the time of submission.

It was shown during the field tests that savings of up to 50% in management staff time could be made using a prototype set of measurement rules. It was thought that the use of Builders' Quantities would also result in saving in construction costs and had implications for use in decision making by higher management.

The work was documented in report form and submitted to the Science and Engineering Research Council who awarded the project a grade of excellence, the highest possible category.

FOREWORD AND ACKNOWLEDGEMENTS

Foreword

This thesis is based on a research programme undertaken in the Civil Engineering Department of Loughborough University of Technology between 1984-1988. The research programme was funded by the Science and Engineering Research Council and was aimed at developing a suitable method of measuring Builders' Quantities for use by small/medium sized contracting organizations as a management tool for the preparation of tenders to the completion of the construction work and the final account.

The hypothesis behind the research was based on an observation that the construction industry was making increasing use of tender documents without quantities. This observation called into question the validity of existing methods used by contractors for preparing tenders and the usefulness of this tender information for the subsequent post-contract management of projects. This view was supported by the Chartered Institute of Building who had independently formed a working party to examine the post-contract use of estimators data with a view to publishing guidelines for streamlining the work undertaken by the contractors management personnel during the period leading in to the commencement of site works.

Caveate: It must be emphasised here, to avoid subsequent confusion, that all the research was undertaken within contracting organizations and the results intended for use by contracting organizations only. At no time was it deemed possible or practical to develop a method of preparing quantities that reflected contracting construction and management methods for use by client bodies. Indeed, contractors of all sizes agreed that the Client must not be allowed nor encouraged to attempt to impose such considerations upon the industry.

Acknowledgements

The hypothesis for this research was based on ideas put forward by Professor Ronald McCaffer in collaboration with Mr John Walkerdine (PPCIOB) and it is with gratitude that I acknowledge that without their guidance and assistance this work would not have been possible. Mr Walkerdine attached particular importance to this research and allowed total freedom for investigation and involvement within all departments of his construction company, to the extent of providing a paid, temporary surveying position within the company with which the research content was examined and practical solutions developed.

Collaborating bodies

Various contracting organizations and personnel associated with the construction industry provided facilities, advice and sample contract documentation during the research. Acknowledgement and thanks are offered to the following who provided valuable assistance:

(i) Participating contracting organizations:

Charles Gregory Ltd, Loughborough, Leics; Lovell Farrow Ltd, Chiswick, London; Lovell (Midland) Ltd, Aylesbury, Bucks; MSBT Ltd, Loughborough, Leics; Wates Ltd, Norden, London; Wm Moss Ltd, Loughborough, Leics; and Wm Walkerdine Ltd, Derby.

Assistance was given by personnel from the various departments within each organization, who discussed the research subject and made suggestions regarding the methods of achieving its declared aims. These personnel also provided documentary examples of individual and company methods of preparing and utilising measured data, along with examples of tender documentation prepared by clients.

(ii) Individual assistance:

Particular thanks are extended to the following people who provided individual attention and help:

Mr John Grundy, formerly of Wm Walkerdine Ltd, Derby, provided information about the role of an estimator and the problems encountered during the preparation of tenders. Mr Michael Butler of Wates Ltd, London provided an insight into site management and the allocation of resources, along with the role undertaken by higher management and the formation of company policies.

Mr Harold Hussey of London was able to provide a large bibliography of publications and articles referring to work undertaken by various bodies to formulate coding systems for measured data. During his employment by the Building Research Establishment in the 1960's and 1970's Mr Hussey had worked on research projects that examined the division of site works into operations. The findings of this research were subsequently published by BRE. Mr Hussey was able to provide much background information about methods of undertaking research generally and his own experiences during the research into Operational Bills whilst at the BRE.

Mr David Potter, formerly of Lovell Construction Services Ltd, Uxbridge, who was also involved with the CIOB working party examining postcontract use of estimating data, was able to provide critical analysis of the proposals, findings and draft sets of measurement rules.

Mr Edward Skoyles, who undertook considerable research into related fields whilst employed by BRE, provided critical assessment of the theory of builders' quantities and further contacts within the industry of people who would be able to assist with parallel considerations.

(iii) Other bodies : other bodies providing assistance included:

The Chartered Institute of Building who permitted me to attend meetings of their working party examining the post-contract use of estimating data. Advice and assistance was received from various members of this working party, most notably Mr M Butler, Chairman and Mr G Spiers, Author.

Employees of the Building Research Establishment were also most helpful, particularly as the BRE has undertaken considerable research into related fields. Particular assistance was received from Mrs Addison regarding preliminary items and Mr Stevens regarding monitoring and documenting site works. I gratefully acknowledge Harry F. Wolcott who provided much reassurance in his book "Writing Up Qualitative Research" by describing the acts of avoidance commonly performed by writers. This helped to explain my $\parallel H \partial \omega$. seemingly irrational compulsion to mop the kitchen floor.

CO	N	Т	E	N	T	S
----	---	---	---	---	---	---

			Page
FOREWOR	D AND	ACKNOWLEDGEMENTS	(i) - (iv)
Chapter 1:	Back	ground and Hypothesis	1
	1.1	Introduction	1
	1.2	Rationale	1
	1.3	Hypothesis	3
	1.4	Aims and Objectives	3
Chapter 2:	Intro	duction to Structure of Thesis	7
	2.1	Introduction	7
Chapter 3:	Meth	odology	11
	3.1	Introduction	11
	3.2	Information Required	11
	3.3	Literature Review	14
	3.4	Case Studies	15
	3.5	Expert Opinion	16
	3.6	Requirements of Field Tests	18
	3.7	Selection of Test Projects	19
	3.8	Testing the Findings	20
	3.9	Evaluation of the Tested Work	21
	3.10	Conclusion	22
Chapter 4:	Liter	rature Review	23
	4.1	Introduction and Objectives	23
	4.2	Methodology	23
	4.3	Building Research Establishment	23
	4.4	Royal Institution of Chartered Surveyors	25

	4.5	The British Property Federation	28
	4.6	The Chartered Institute of Building	30
	4.7	Conclusion	32
Chapter 5:	Appr	aisal of Existing Data and Uses	33
	5.1	Introduction	33
	5.2	Existing Tender Documentation	33
	5.3	Examination of Traditional Bills of Quantities	34
	5.4	RICS Standard Method of Measurement	34
	5.5	Content of Traditional Bills of Quantities	35
	5.6	Accuracy of B/Q Measured Data	37
	5.7	Advantages and Disadvantages of Client	
		Originated B/Qs	37 ·
	5.8	Contractors' Data Requirements	41
	5.9	Shortfalls of Traditional Bills of Quantities	42
	5.10	Definition of Data and Measured Data	43
	5.11	Definition of Tasks Performed	45
	5.12	Definition of Management Function Groups	46
	5.13	Definition of Cost and Price	50
	5.14	Conclusion	52
Chapter 6:	Deta	iled Data Study	53
	6.1	Introduction	53
	<u>SEC</u>	TION A: ESTIMATING MANAGEMENT FUN	CTION GROUP
	6.2	Definition of the Estimating Management	
		Function	53
	6.3	Evaluation of Estimating Procedures	54
	6.4	Information Used by the Estimator	55
	6.5	Data Received by the Estimator	56
	6.6	Data Generated by the Estimator	56
	<u>SEC</u>	TION B: PURCHASING MANAGEMENT FU	NCTION
	GRO	<u>UP</u>	
	6.7	Definition of the Purchasing Management	
		Function	59

-

6.8	Evaluation of the Purchasing Procedures	59
6.9	Information Used by the Purchaser	61
6.10	Data Received by the Purchaser	61
6.11	Data Not Used by the Purchaser	62
6.12	Data Transformed by the Purchaser	62
6.13	Data Generated by the Puchaser	63
6.14	Data passed on by the Purchaser	64

.

SECTION C: PLANNING MANAGEMENT FUNCTION GROUP

6.15	Definition of the Planning Management			
	Function	65		
6.16	Evaluation of the Planning Procedures	66		
6.17	Information Used by the Planner	66		
6.18	Data Received by the Planner	67		
6.19	Data not used by the Planne	67		
6.20	Data Transformed by the Planner	68		
6.21	Data Generated by the Planner	68		
6.22	Data Passed On by the Planner	68		

SECTION D: SURVEYING MANAGEMENT FUNCTION GROUP

6.23	Definition of the Surveying Management			
	Function	70		
6.24	Evaluation of Surveying Procedures	71		
6.25	Information Used by the Surveyor	72		
6.26	Data Received by the Surveyor	73		
6.27	Data Not Used by the Surveyor	73		
6.28	Data Transformed by the Surveyor	73		
6.29	Data Generated by the Surveyor	75		
6.30	Data Passed On by the Surveyor	76		

SECTION E: SITE MANAGEMENT FUNCTION GROUP

6.31	Definition of the Site Manager's Management		
	Function .	78	
6.32	Evaluation of Site Management Procedures	78	
6.33	Information Used by the Site Manager	81	
6.34	Data Received by the Site Manager	81	
6.35	Data Not Used by the Site Manager	82	
6.36	Data Transformed by the Site Manager	82	

	6.37	Data Generated by the Site Manager	82	
	6.38	Data Passed On by the Site Manager		
	SECTION F: HIGHER MANAGEMENT FUNCTION			
	6.39	Definition of the Higher Management Function	84	
	<u>SECT</u>	ION G: CONCLUSIONS		
	6.40	Conclusions	85	
Ch 47-	Data	Flow and Interfaces	86	
	Data riow and interfaces 86			
	7.1	Introduction	86	
	SECTION A: DATA FLOW			
	7.2	Generally	86	
	7.3	Contract Stages	87	
	7.4	Sequence of Tasks	88	
	7.5	Pre-commencement Stage	90	
	7.6	Construction Stage	90	
	SECT	ION B: DATA INTERFACES		
	7.7	Generally	93	
	7.8	Estimating Data Interfaces	94	
	7.9	Purchasing Management Function	95	
	7.10	The PlanningManagement Function	96	
	7.11	Surveying Management Function	97	
	7.12	Site Management Function	97	
	7.13	Double Interfaces	97	
	SECT.	ION C. CRITICAL MANACEMENT TASKS		
	<u> 3ECI</u> 7 14	Conomity	00	
	7.14	Comparing of Management Tacks	99	
	7.15	Critical Data	100	
	1.10	CINCAI D'AIA	100	
	SECT	ION D: CONCLUSIONS		
	7.17	Conclusions	101	

.

.

•

.

٠

Chapter 8: Considerations and Principles for Measurement Rules 104 8.1 Introduction 104 SECTION A: MEASURED DATA FOR CRITICAL TASKS 8.2 The Purchaser 105 8.3 The Planner 107 8.4 The Surveyor 108 8.5 The Site Manager 112 SECTION B: THE ROLE OF THE DOMESTIC SUB-CONTRACTOR 8.6 Generally 113 8.7 Relationship with the Management Functions 113 SECTION C: FORMAT FOR PRESENTATION 8.8 Generally 116 8.9 **Preliminaries** 116 8.10 Construction Works 116 SECTION D: CONSIDERATIONS COVERING THE METHOD OF MEASUREMENT 8.11 Generally 120 8.12 Resource Split 120 8.13 Buying Unit 121 SECTION E: PRINCIPLES OF MEASUREMENT FOR BUILDERS' QUANTITIES 8.14 General Constraints 123 8.15 General Measurement Principles 124 8.16 Excavation and Groundworks 125 8.17 Labour Resource 126 8.18 Material Resource 127 8.19 Plant Resource 128

SECTION F: DEVELOPMENT OF STANDARD TAKE-OFF SHEET

•

.

.

	8.20	Generally	130
	8.21	Initial Taking-Off Sheet Format	130
	8.22	First Draft of Single Taking-Off Sheet	131 ·
	8.23	First Revision of Single Taking-Off Sheet	133
	8.24	Final Taking-Off Sheet Design	133
	<u>Sect</u>	ION G: DEVELOPMENT OF THE MEASUR	<u>EMENT</u>
		RULES	
	8.25	Generally	138
	<u>Sect</u>	ION H: CONCLUSIONS	
	8.26	Conclusion	138
Chapter 9:	Mcasu	rement Rules	139
	9.1	Introduction	139
	9.2	Sub-structure	144
	9.3	Super-structure	160
	9.4	External Works	174
	9.5	Alterations	188
Chapter 10:	Supp	lementary Information for the Use of	
		Measurement Rules	192
	10.1	Introduction	192
	<u>SECT</u>	ION A: GENERALLY	
	10.2	Supporting Documents	192
	10.3	Tolerances	
	<u>SECT</u>	ION B: CLARIFICATIONS AND DEFINITION	<u>DNS</u>
	10.4	Abbreviations and Terms Used Generally	193
	10.5	Clarifications	195

	<u>SECT</u>	ION C: USE OF METHOD STATEMENTS	
	10.6	Definition	206
·	10.7	Minimum Requirements	206
	<u>SECT</u>	ION D: CONCLUSIONS	
	10.8	Conclusions	209
Chapter 11:	Evalu	uation of the Tested Work	210
	11.1	Introduction	210
	11.2	Estimating Management Function	210
	11.3	Purchasing Management Function	211
	11.4	Surveying Management Function	212
	11.5	Planning Management Function	213
	11.6	Site and Higher Management Functions	213
	11.7	Conclusions	213
Chapter 12:	Sum	mary and Conclusions	215
	12.1	Summary of Research Findings	215
	12.2	Conclusions	218
	12.3	Significance of Results	219
	12.4	Scope for Further Research	220
	12.5	Publications	221
	12.6	Reports	222
	12.7	Proposed Publications	223
	12.8	Work Files	223
References	Cited		

-

Bibliography

.

.

Appendix A:	SERC Applications and Assessments	
Appendix B:	Case Studies	
Appendix C:	Existing Data and Standard Data Sheets	

Appendix D:	Interviews with Experts	
Appendix E:	Field Trials - Evaluation of Tested Work	
Appendix F:	Publications	

.

. .

,

CHAPTER ONE : CONTENTS

BACKGROUND AND HYPOTHESIS

- 1.1 Introduction
 1.2 Rationale
 1.3 Hypothesis
- 1.4 Aims and Objectives

CHAPTER ONE

BACKGROUND AND HYPOTHESIS

1.1 INTRODUCTION

The research undertaken for the study of Builders' Quantities and their use within the management structure of contracting organizations was grant funded by the Science and Engineering Research Council (SERC). The rationale for the research was set down in the first of two successful SERC grant applications. Satisfactory completion of the first funded research period resulted in the second application being made and further funds being granted to allow the field trials of the results of the earlier work. Copies of both SERC grant applications are contained in Appendix A. - 2

1.2 RATIONALE

It was argued by McCaffer (1) that for many decades pre-contract procedures, particularly in the United Kingdom building industry, were dictated by the client/design/quantity surveyor/contractor relationship. This relationship had been enshrined in the various standard forms of contract and, in particular, those produced by the Joint Contracts Tribunal.

McCaffer further maintained that, during the contract, the Bills of Quantities produced at pre-contract design stage were used for the measurement of variations, the preparation of interim valuations and the final account. Because the Bills did not have to be quantitively accurate - and indeed seldom were (the use of Provisional Sums being one example) - they were of little subsequent use to the contractor whilst he was carrying out the construction phase, other than as a specification.

Because the standard method of measurement on which the Bills were based was unrelated to the more practical requirements of the construction process, such as purchasing, labour procurement, calculation of wastages, planning and bonusing, all of which required different systems of measurement, the Bills of Quantities, even if accurate, could not be used without considerable additional work and transformation.

1

McCaffer concluded that the unsuitability of the Bills of Quantities for what might be called "a contractors' management tool" was not surprising considering that the industry's Joint Consultative Committee and Joint Contracts Tribunal in their forms of contract, codes and standard methods imply that the purpose of Bills were to:

- 1. describe and specify the work adequately even though measurement might not be correct;
- 2. obtain several tenders on a fair and equitable basis; and
- 3. value variations, interim and final payments of the contract.

McCaffer felt that the gap between the Bills of Quantities and the requirements of the "Contractors Management Tool" was enormous. The gap was only bridged by the compensating work of the various sections in the contracting organizations. Often the bridging was not attempted and the "Contractors Management Tool" was either a fresh document, sometimes prepared separately by each section, or, because of the resources involved, not even attempted.

McCaffer argued that because growing pressures by the client, contractor and, sometimes, designer, the traditional four-cornered relationship, described earlier, was being eroded. The client was impatient of the time lag between brief and contract start and, often himself a manufacturer, did not understand the concept of design being apart from production and the wrangles that ensued. The contractor, an entrepreneur and often trained manager, saw a market opportunity in the impatience of the client and embraced the design function. Many designers who had not seen themselves as managers anyhow, were happy to join any permutation or combination that provided them with work and allowed them to get on with their perceived "real job" of design.

The adoption of the design function by contracting organizations had the effect of changing the tender documents. Now the Client was only required to provide a performance or outline specification with perhaps a budget figure, the Contractor was free to prepare measured quantity data in a format that suited the management structure of the company.

Analysis of the rationale described led to the formulation of the hypothesis underlying the research.

1.3 HYPOTHESIS

The hypothesis for the research was put forward as:

"A study of existing data flow within contracting organizations would reveal interfaces where compensating work was undertaken by the contractors' management personnel. This compensating work could be reduced if the contractor prepared the pre-contract data in a format that reflected both the contractors' method of construction and the method of managing the construction resources".

1.4 AIMS AND OBJECTIVES

The research therefore comprised a twofold aim in firstly, identifying a need for the "Contractors Management Tool" described in the rationale and secondly, developing a set of measurement rules for Builders' Quantities to fulfil that need.

The primary objective for the research, however, was the definition of a set of measurement rules for use by contractors for the preparation of quantity. data that reduced the compensating work undertaken by the various postcontract management personnel and streamlined the data flow within the organization. These measurement rules would form the basis of a standardized management system. It was thought that the results of this research would be of most use to small to medium sized construction companies for the following reasons:

 Large international and multi-national construction companies already had standardized measurement systems which included facilities for breaking down measured data into individual resource requirements by the use of computer software. This software was often specified individually by the company concerned and therefore reflected their particular management requirements, eg CATO specified and developed by John Laing PLC. **(ii)** Small/medium construction companies did not have the resources to develop individually tailored computerized systems and relied very much on the measured quantity data prepared for the tender documents by the Clients' and Quantity Surveyor. It was within these organizations that the greatest difficulties were encountered in the use of the contract documentation as a management tool. It appeared that two entirely separate systems operated, one using the contract documents and used to generate income via the interim certificates and an internal system generated as and when required to procure resources for the construction work. Although some crosschecking was undertaken it was often not until the work was completed that the actual financial position was calculated. This was quite unsatisfactory in terms of the efficient management of the construction works even though it represented the traditional methods used since the Great Fire of London 1666 when the construction industry underwent the radical changes from which current practices sprang. This apparent inefficiency probably led Dr Samuel Johnson to observe "to build is to be robbed" more than 200 vears ago(2).

iii) How was

There were many more small/medium sized companies in the UK than large ones. Statistics compiled by the Department of the Environment show that over 90% of companies in the UK employed less than 25 people between 1977-1987 (see Table 1.1 below).

Therefore the main objective of the research was to develop a set of measurement rules that allowed measured quantity data to be prepared, which would allow the easy transfer of relevant data between the management personnel of small/medium sized contracting organizations. This measured data would then form the basis of the contractors' management tool identified by McCaffer⁽³⁾.

l Year	2 Number of construction firms	3 Number employing between 1 and 24 people	4 Column 3 as a percentage of Column 2 %
1977	77642	71717	92.37
1978	91520	85362	93.27
1979	101080	94561	93.55
1980	113632	107558	94.65
1981	115186	109849	95.37
1982	144395	139243	96.43
1983	160596	155522	96.84
1984	169999	165163	97.16
1985	167825	163218	97.25
1986	171600	167211	97.44
1987	175095	170463	97.35

Table 1.1: Number of small firms in the construction industry. Table extracted from Table 3.1 Department of the Environment construction statistics. (Figures relate to number of private contractors in the DoE register).

In fulfilling the primary objective, preliminary studies that identified and defined the need for the set of measurement rules had to be successfully undertaken before work could begin on their development. The research to identify this need included:-

- the documentation of which quantity data was used and what it was used for;
- the definition of the tasks performed by the management personnel; and
- the identification of management "functions" within contracting organizations.

The study undertaken to establish the need within contracting organizations for a set of measurement rules for Builders' Quantities, revealed the existence of so called "data interfaces". The aims for this portion were expanded therefore to include:-

- the definition of the data interfaces; and
- to plot the flow of data within and between the management functions showing where the interfaces occurred.

The identification of the interfaces became a vital step in the research process, as without the definition of barriers and difficulties within the data flow, recommendations to improve and streamline the data flow could not be made.

It can be seen, therefore, that although the definition of a set of measurement rules for Builders' Quantities was the primary objective, it was important that the need for these rules was identified. Indeed the primary objective relied upon the need being identified.

The steps taken to achieve the objectives and the research methods adopted are detailed in Chapter 3 Methodology.

CHAPTER TWO

INTRODUCTION TO THE STRUCTURE OF THE THESIS

-

.

2.1 Introduction

CHAPTER TWO

INTRODUCTION TO THE STRUCTURE OF THE THESIS

2.1 INTRODUCTION

This thesis describes research undertaken substantially in the field by observation (both participant and non-participant), interview and systematic development which drew upon the professional skills of the researcher (a Chartered Quantity Surveyor with some six years experience in the construction industry). This type of field orientated research was described by Wolcott⁽⁴⁾ as "qualitative or qualitative/descriptive". Qualitative research was further described by Kirk and Miller⁽⁵⁾ as ".... a "qualitative observation" identifies the presence or absence of something, in contrast to "quantitative observation" which involves measuring the degree to which some feature is present" stating also that ".... "quality" connotes the nature, as opposed to "quantity" or amount, of a thing".

The work comprised a study of measured quantity data used by the management personnel of construction companies and sought to identify the type and scope of the data, the individual tasks for which it was used, the degree to which available data was useful without change and what changes were required to enable data to be of use to the various management personnel. This study was to be undertaken to allow the development of a set of measurement rules which allowed the preparation of measured quantity data that could be used by the management personnel without change or transformation. The rationale behind the research is described in Chapter 1.2 where arguments for the work were put forward in more detail and a hypothesis laid down. The hypothesis is given in Chapter 1.3.

The nature of the work, however, was complex and required the exploration of many facets of the management of construction projects. This exploration had the consequence of revealing further and additional areas for investigation. This resulted in the hypothesis given becoming loose 'terms' of reference' rather than a narrow set of conventions against which to test the analytical "truth" of the statement made. Indeed this situation is common in qualitative research. According to Kirk and Miller⁽⁶⁾ "Hypothesis testing is not the only research activity in any scientific discipline" going on to add "... hypothesis testing is appropriate to only a small proportion of the questions they (social scientists) ask. Qualitative research being intrinsically exploratory, (it) explicitly departs from certain structures of the hypothetico - deductive model". This meant that the research found much of its direction as it progressed from one objective to another within the broad definition of the hypothesis. It was, therefore, important that the focus of the work was not lost and that the ultimate research aims were clear and well defined and these are detailed in Chapter 1.4.

The thesis goes on to describe the methodology adopted during the various stages of the research and the development work. Chapter 3 outlines how some of the problems of undertaking qualitative research were tackled and shows how the research was structured in order to define and subsequently achieve the objectives set. The development and testing of the proposed measurement rules also followed a structured approach although the more desirable method of testing within contracting companies by the management personnel involved proved to be impossible and an alternative method of working in parallel was adopted. It was during this stage that the professional skills and constructional knowledge of the researcher proved most valuable.

The body of this thesis contains the findings from the observations, interviews, cast studies and other data collection methods. Descriptions and appropriate examples of the actual data collected is held in the Appendices. The reason for this approach to writing up the work is to remove as much repetitive and bulky text as possible. It will be found upon reading through the thesis that each chapter contains a brief summary or description of the data relevant to that portion of the work under discussion only, the chapter will mainly comprise detail of the findings after the analysis of the data. Where appropriate, description of the method of analysis will be given within the relevant chapter also. The result of this approach is to make each chapter self-contained, allowing it to stand alone as well as providing background information for subsequent chapters.

Kirk and Miller recognized that although qualitative research relaxed certain of the narrow definition of the hypothetico-deductive model, it would be erroneous indeed to abandon scientific objectivity⁽⁷⁾. To this end opinion within the industry was extensively sampled through the methods detailed in

8

Chapter 3. One major method of such sampling is a literature search and review. The findings of the literature review are described in Chapter 4. This review found that little had been published regarding the measured quantity data requirements for the management of construction projects. However, there were several bodies who had been and, in the case of the Royal Institution of Chartered Surveyors, continued to be, involved with research into the measurement of construction work. This body of research was examined and the findings given in the literature review.

After reviewing this previous research work, it was then necessary to observe and document the existing data and its uses. Chapter 5 of the thesis contains these observations and also goes on to describe the contractors data requirements in 5.9. The remainder of the chapter (5.10 - 5.14) details the findings of these observations, defining the terms data, measured data, tasks performed, management function groups, and cost and price.

Once the basic definitions were laid down, it was then possible to examine the data uses for each management function in detail, identifying which data was not used, which transformed, which generated and which passed on to other management functions. This was identified for each of the previously defined management functions and is described in Chapter 6. The detailed data study described in Chapter 6 allowed the identification of which data was useful and which was not it was then possible to trace the flow of measured quantity data showing the sequence of the management tasks and the progression through the contract stages. This data flow is described in Chapter 7, Section A.

Chapter 7 goes on to describe in Section B, the data interfaces where data was undergoing transformation or being regenerated as it was passed within and between the management functions. This therefore pinpointed places on the flow chart where improvements could be made in the original data format that would overcome the difficulties arising at the interfaces. The identification of the interfaces permitted an assessment of where and for which tasks the format of the measured data was critical (Chapter 7, Section C).

The particular data requirements for the critical tasks were examined within each of the management functions and documented in Chapter 8, Section A.

Chapter 8 went on to examine the influence of domestic sub-contractors as they were found to affect many of the management functions of construction organizations. The findings of the particular data requirements for the critical tasks of the management function gave rise to a summary of the main factors for consideration in the development of the measurement rules and the principles for the method of measurement and the development of a standard "taking-off" sheet, all of which are described in Chapter 8.

The resultant prototype set of measurement rules for Builders' Quantities are held in Chapter 9. These measurement rules had been developed and evaluated with the co-operation of five contracting organizations. The rules comprise of tabulated measurement requirements listed in construction sequence and are followed by a form of "User Guide" in the form of the supplementary information contained in Chapter 10. This chapter details the documents that are required to support the measured data (10.2) and gives the definitions of abbreviations and terms used (10.3) along with clarifications of the intentions of the measurement rules (10.4). The use of a method statement in support of the measured quantity data was considered sufficiently important to warrant the detailing of its use separately in Chapter 10, Section C.

A summary of the evaluation and development process is given in Chapter 11. The effect of the use of the measurement rules is considered for each management function in turn based upon the field testing documented in Appendix E. It was significant to note that it was estimated that a saving of upto 50% in management personnel time could be made (11.4).

The research work is summed up in Chapter 12 where findings and conclusions drawn are listed (12.2). The significance of the work is examined in Chapter 12.3 along with the identification of scope for further research work in Chapter 12.4.

Some of the work undertaken for the research and development of the measurement rules for Builders' Quantities has already been published. These publications are listed in Chapter 12.5 and copies are given in Appendix F. Chapter 12 is the last chapter in the thesis and is followed by the list of references, and the bibliography and the appendices.

CHAPTER THREE

.

METHODOLOGY

3.1	Introduction
3.2	Information Required
3.3	Literature/Research Review
3.4	Case Studies
3.5	Expert Opinion
⇒ 3.6	Requirements of Field Tests
-> 3.7	Selection of Test Projects
⊕ 3.8	Testing the Findings
3.9	Evaluation of Tested Work
3.10	Conclusion

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter of the thesis describes how the research was undertaken, data analysed and the Measurement Rules for Builders' Quantities developed. Qualitative research of the type undertaken for this work may often appear to be unscientific in method, indeed Kirk and Miller state that "Many have argued that social science has an intrinsically different set of goals that call for an altogether separate collection of methods".⁽⁸⁾ But all researchers share an inspiration to be objective whatever their scientific discipline. One useful methodological formulation adapted from other traditions for use in qualitative research is to partition objectivity into two components; reliability and validity.

"reliability": is the extent to which a measurement (observation) procedure yields the same answer however and whenever it is carried out; "validity": is the extent to which it gives the correct answer.

Kirk & Miller, p.19

In terms of reliability, the answer to the question "what are the basic construction resources?" will always reveal a combination of the five "M's", in other words men, machinery, materials, management and money. This answer is also valid in that all of these resources combine to varying degrees in all construction work no matter what the size or type of project. This question was never directly asked during the research as it was considered to be an absolute "truth" accepted by all involved with construction. However, the reliability of the bulk of the research must be considered to be subjective to a degree in that the answers are coloured by the personal opinions and references of the researcher and the participants as the study concerns how a group or groups of/ people act individually and together.

In order to retain objectivity and validity within the findings, some method of triangulation was required whereby the findings were double checked with non-participant experts. It can be seen from this that the methodology for the research was complex and required a high degree of structure if the work was to achieve a satisfactory degree of reliability and validity.

This structure was summarized by the following steps:

- to identify what information was required;
- to survey available literature and related research;
- to undertake case studies;
- to seek individual expert opinion to validate findings of the case . studies;
- to identify what was required from the field tests;
- to select suitable test projects;
- to test the findings; and
- to seek critical evaluation of tested work to provide validity to the findings.

Whilst work was undertaken within the structure identified above, it was found, however, that much of the work involved in one step overlapped with work undertaken in one or more of the others. This resulted in fragmentation of the structure with work undertaken in two or more areas concurrently. This fragmentation and overlap was plotted on a bar chart to clarify the documentation of the methodology (see Table 3.1).

For the purpose of writing up, the steps taken have been described individually in a logical but not necessarily chronological order.

3.2 INFORMATION REQUIRED

In order to achieve the objective of developing a set of measurement rules for Builders' Quantities it was first necessary to identify what information was required. This would also provide a framework within which to work and maintain a structured and scientific approach to the research. Initially this information was outlined as follows:

- (a) the definition of the use to which measured quantity data is put in the management functions of estimating, purchasing, cost control and planning by research within contractor companies;
- (b) the determination of the quantity data that should be measured for the benefit of the management functions.
RESEARCH PROGRAMME



//TABLE 3.1

13

.

.

.

Commencement of the research project revealed that the use and definition of quantity data was a much larger subject than was at first envisaged. This resulted in refinement of (a) above, to include the definition and identification of the following:

- (i) the management functions within construction organizations;
- (ii) the tasks performed by each management function;
- (iii) the information used by each management function;
- (iv) the flow of information within and between each management function; and
- (v) the repetition, alteration and generation in the use of the defined information by the management functions.

After a period of eighteen months, a preliminary set of measurement rules for Builders' Quantities was drafted. A further period of thirty months was set aside for the completion of the work required for (b) and the field testing of the results.

3.3 LITERATURE REVIEW

An initial review of available literature was undertaken to assess previous and related work in this field. As the research progressed and the methodology refined, the survey of published works was continued. Much of the literature was called for from the library interchange facilities available at Loughborough University but some was found to have been published in professional and trade magazines. The review and the conclusions drawn are detailed in Chapter 4. The review of literature was considered an important method of assessing the reliability and validity of the work by providing direction and confirming the rationale and hypothesis. The literature review provided a secondary source of data.

3.4 CASE STUDIES

The primary source of data for the study of Builders' Quantities was contracting organizations. The method of gathering data within these organizations was termed "Case Studies" rather than "Field Studies" so as not to be confused with "Field Tests" (vide infra 3.6, 3.7, 3.8 and 3.9). However by nature the data collected took the form of notes gathered in the field and was detailed in Appendix B. The data gathered was qualitative as explained previously, and could therefore be considered to be subjective. However the analysis by tabulation revealed similarities close enough to allow the data to be standardized across the organizations studied. This standardization was then held to be an industry standard which was put forward to experts outside the participating contracting organizations for validation by triangulation.

The case studies were undertaken within three contracting organizations over a six month period. During the case studies personnel undertaking the various management functions were informally interviewed and observed undertaking/ the tasks allocated to them.

The purpose of the interviews was to establish the opinions held by individual professionals involved in the procurement and management of construction contracts regarding the shortfalls of using quantity data prepared by the client. These professionals were also encouraged to provide suggestions regarding methods of improving data presentation, with particular reference to abstracting data for their own management tasks.

No formal questionnaire was used for the interviews as the interviewees had individual and differing approaches to their job description and method of achieving their management tasks. However, a basic interview framework was:

- 1. What title do you allocate to the job you undertake?
- 2. What does this job comprise?
- 3. What types of tender documentation do you deal with?
- 4. How do you use the information given to you to perform your job?
- 5. What do you think of the format of traditional Bills of Quantities?
- 6. How could the format of information supplied to you be improved?

Although this basic framework was compiled it was found that, once the interviewee understood the purpose of the interview, the information was volunteered without prompting. The results of the interviews gave rise to a detailed appraisal of the type of data being used by the contracting organizations. The interviews highlighted the need to define not only the data used but also the tasks performed and the management function undertaking these tasks.

The information gained from informal interview sessions supplemented the more detailed knowledge gained by observation of the management functions performing the various tasks allocated to them. The type of data required and the uses to which it was put were also observed and classified into sections that illustrated which data was used, which was transformed, which was ignored and which was specifically re-generated. The flow of the data used was observed, along with the interfaces through which data could not, or was not, passed.

The data gathered during the case studies therefore fulfilled the information requirements identified in 3.2 and uncovered the so-called "interfaces" hitherto suspected, the definition and study of which was undertaken with the development of the measurement rules during the Field Tests (vide infra 3.6, 3.7, 3.8 and 3.9).

3.5 EXPERT OPINION

Validation through triangulation as described in 3.1 was undertaken by discussing research with eminent practitioners in the industry (vide Appendix D). Some of these practitioners were directors of the companies involved in the case studies who were very interested not least in seeing an "outsider's" appraisal of their company, but all of whom were actively involved in promoting improvements in construction practice and management within and outside their own organizations. Some of the practitioners were not involved with the case study companies but were nonetheless interested.

This expert opinion upon the merits of the work and critical review of observations and results to date were sought from eminent sources throughout the research period. This opinion was obtained by informal interview.

The experts participating in the research by allowing access to their contracting organizations were:

Mr John Walkerdine	- a founder sponsor for the work with a direct interest in improving post-contract data management within contracting organizations:		
Mr David Potter	- whose involvement with the CIOB gave him an		
	interest in the project which was supplemented by his position within a contracting		
	method of improving management methods.		
Mr Michael Butler	- whose involvement was similar to Mr Potter's.		

Expert opinion outside involved parties was also sought throughout the research period. These experts comprised:

Mr Harold Hussey	- undertook work with the <u>BRE</u> regarding "Building Language".	a		
Mr Edward Skoyles	who was approached as a result of his work with the BRE.			
Iris Addison and				
Alan Stevens	- both with the BRE.			
Professor Peter Brandon	who undertook a brief review and critical appraisal of the completed works, including suggestions for pursuing the work into the commercial market.			

The input from expert opinion took the form of guidance in the direction of the / research. The research topic was well received, although some limitations were / pointed out, as were areas that required deeper research. This input and the conclusions drawn are detailed in Appendix D.

17

3.6 **REQUIREMENTS OF FIELD TESTS**

Once a draft set of measurement rules had been compiled from the case studies, a method of testing the rules was required in order to validate the recommendations of the rules. It was important that the field tests had clear objectives themselves therefore objectives were set which comprised initially the following:

- (a) to field test the determined measurement rules with up to three suitable contracts;
- (b) to determine who might benefit most from the findings;
- (c) to publish the findings, probably via the Chartered Institute of Building.

The field tests outlined in (a) above were also refined and expanded as the work progressed to include the following:

- (i) To field test the use of Builders' Quantities, defined during the first part of the research period, within the functions of:
 - estimating;
 - planning;
 - purchasing;
 - surveying; and
 - site management;

on at least two, and preferably three, projects.

- (ii) The information and feedback obtained during the first field tests were used for the following:
 - (i) to define the data interface and transfer between the functions;
 - (ii) to refine and extend the definition of Builders' Quantities based on the results of the field tests; and
 - (iii) to field test the re-defined measurement rules on the second and/or third projects; and

(iv) to document the use of Builders' Quantities for use as an operational manual by the various function groups.

During the research a slight change in direction was made to accommodate and increase in the scope and content of the project. It was found that the higher management functions made use of and had requirements for, measured data. The higher management function was therefore examined and the findings were then incorporated into the measurement rules.

3.7 SELECTION OF TEST PROJECTS

. Not random?

The <u>selection</u> of the test projects was left to the <u>discretion</u> of the participating <u>contractors</u>. It was deemed that they had sufficient involvement with both the research and the work undertaken by their companies for the selection of a suitable project. However, a shortlist of <u>selection criteria</u> was agreed upon prior to selection, comprising:

- simplicity of construction; to enable first principles of measurement to be thoroughly tested prior to application to more complex work;
- inclusion of as many trades as possible; to enable testing of as large a variety of site work as possible;
- construction period not exceeding 12 months; to allow testing to be undertaken within the remaining research period of twentyfour months;
- projects to be live wherever possible; to allow discussions with the management personnel whilst the works were fresh in their minds.

Only <u>successful tenders</u> could be considered, to ensure that the post-contract management would be undertaken. This had two consequences:

- (a) limiting the number of projects to be considered; and
- (b) delaying the commencement of testing until the post-contract stage, which resulted in pre-contract testing being undertaken out of sequence.

The projects selected and the contracting organizations supplying them were:

			No constant
Charles Gregory Ltd	:	Alteration and Extension, Kibworth Co-op;	unk ine
MSBT Ltd	:	Remedial work, Church, Melton Mowbray;	New, martenale
Wates Ltd	:	Office & High Tech Development, Slough;	Sall/bigcil.
Wm Moss Ltd	:	MIRA Building, Nuneaton; and	
Wm Walkerdine	:	Alteration and Extension, School, Derby.	

3.8 **TESTING THE FINDINGS**

Interactions of complex Variables The desired method of testing was for the contractors' personnel to use the measurement rules themselves for the live projects, assisted by the researcher. However, support for this method could not be found among the participating contracting organizations due wholly to the cost this would involve (vide Appendix D; Butler). Therefore, the testing was undertaken solely by the researcher.

The measurement rules drafted as a result of the findings of the case studies were applied to the selected test projects. The projects were tested in the order in which they were received, which in turn was governed by the dates the contracts were entered into. The testing sequence was:

- 1. MIRA building;
- 2. School:
- 3. Church;
- 4. Co-op store: and
- 5. Office development.

Testing took place outside the contracting organizations with the researcher working in parallel with the contractors' management personnel. Initially the testing took place concurrently with the contractors' management personnel, however it was not possible to maintain this level of output for the following reasons:

(a) as the initial "pre-contract" data was not prepared until the post-contract stage there was an immediate time lag of some weeks;

20

- **(b)** the number of management personnel involved with the post-contract work was at least three compared to the single researcher.
- (c) the evaluation process itself resulted in further delays due to the need for referral to the contractors' management personnel before refining the measurement and data use process; and
- 16 secus the refinement of the measurement rules resulted in the remeasurement that the (d) um not of the early test projects after the actual completion of the construction. applied

the Cartra

1 64

Marcall

Dan all

н

The method of testing adopted involved the researcher using the measurement rules to prepare data. The researcher then went on to use this data in an attempt to reflect the actual data use occurring within the contracting organization. Variations to the initial contract were ignored because the testing was lagging with time to behind actual sequence of events. The accommodation of variations were found to be either just an increase or decrease in the original quantities or they required all data to be freshly generated. For these reasons it was deemed that the incorporation of variations into the testing would substantially increase the testing time without adding anything to the value of the research.

3.9 **EVALUATION OF THE TESTED WORK**

The evaluation of the tested work by the contractors' management personnel ensured that contracting organizations were contributing to the development of the measurement rules. The evaluation process took less time than the measurement process and consequently required fewer of the contractors' management resources. The degree of participation varied from company to company, however. Three companies, Wm Walkerdine Ltd, MSBT Ltd and Wm Moss Ltd permitted all their management personnel to participate in the evaluation process. The evaluation process within the remaining two firms was confined to a single member of the higher management team.

The work undertaken during the testing was submitted to the contractors' personnel who were responsible for the actual post-contract management of the particular project where full participation was taking place. The work was discussed and compared to the managers' own documentation of the project.

Where full participation was not undertaken, discussions were held with the available staff members. These staff did have considerable managerial experience in one or more of the defined management functions.

21

The findings of these discussions were documented (vide Appendix E) and the conclusions incorporated into the measurement rules.

By this process the measurement rules were refined and redrafted three times. The measurement rules drawn up after the third refinement and redefinition were deemed to be a suitable prototype.

Problems concerning the scope or definition of part or all of a rule were discussed and if it was not deemed necessary to develop a new rule, a clarification note was compiled. These clarifications were then drawn into a separate document that expanded upon and supplemented the measurement document itself and are detailed in Chapter 10.5.

In all, three full revisions of the measurement rules were undertaken. The comments and criticisms of the management personnel involved were recorded, along with the decisions made (vide Appendix E).

3.10 CONCLUSION

Chapter 3 details how the research was undertaken and shows how, typically with a qualitative study, the exploration of the subject revealed further facets that required defining and identifying. However, despite the seemingly everchanging breadth to the study the focus remained constant in that the purpose of the research was to develop a set of <u>Measurement Rules for</u> <u>Builders' Quantities that would enable the preparation of a document that would</u> streamline the data flow.

The methodology adopted evolved as avenues opened up and were explored, however, the researcher was mindful in all cases of the need to maintain as much objectivity as possible through the reliability and validity of the data detailed in the following chapters.

CHAPTER FOUR

LITERATURE REVIEW

- 4.1 Introduction and Objectives
- 4.2 Methodology
- 4.3 Building Research Establishment
- 4.4 Royal Institution of Chartered Surveyors
- 4.5 British Property Federation
- 4.6 The Chartered Institute of Building
- 4.7 Conclusion

CHAPTER FOUR

LITERATURE REVIEW

4.1 INTRODUCTION AND OBJECTIVES

The first step in the research method was the investigation of any existing work of a similar nature. For this reason <u>published data</u> were surveyed to ascertain the extent, if any, of possible duplication and to <u>identify experts</u> in the field who would be able to provide critical assistance and further <u>data sources</u>.

A survey of published data enabled opinion within the industry to be sampled and, as such, could influence the direction of the research and shape of the recommendations.

4.2 METHODOLOGY

The first place of reference was the library at Loughborough University of Technology. The facilities here included comprehensive listing and search of the computer data base as well as inter-library lending.

Continuous reference was made to technical journals, particularly Building and Chartered Quantity Surveyor, <u>throughout</u> the research period. This maintained the opinion sampling to be as current as possible and also provided possible new data sources through advertisements for new books and services.

The analysis of the literature was qualitative, being assessed by virtue of its relevance to the research area and the degree to which relevant literature could contribute to the aims of the research. Each piece of research was analysed and the findings documented (vide infra 4.3 - 4.6).

4.3 BUILDING RESEARCH ESTABLISHMENT

The development of operational Bills of Quantities by the Building Research Establishment. Papers published as a result of the findings of this research were:

The Operational Bill' by W S Forbes and E R Skoyles; Introduction to Operational Bills' by E R Skoyles; Operational Bills and Cost Communication' by D Bishop; 'Examples from Operational Bills' by E R Skoyles; 'A Practical Application of Operational Bills' by W S Forbes and E R Skoyles.

The work described in these papers was undertaken in the early 1960's. The research concentrated on the development of an alternative format for Bills of Quantities prepared on behalf of the client for tendering purposes. In this respect there was no difference in the use of the document from that advocated by the Standard Method of Measurement published by the Royal Institution of Chartered Surveyors. However, the organisation of the Bill sections was designed to reflect the construction sequence to aid the contractors' post-contract management. The system was never fully adopted by the industry although the advent of computerised billing systems have enabled the Bill to be re-sorted, after tendering, into an operational sequence if required. It was not within the scope of this research to investigate the reasons for this apparent failure. However, Mr F R Skoyles, author, suggested this was due to fragmentation of traditional trade sections and a general resistance to change || pervading the industry (vide Appendix D - Skoyles).

Although an apparent similarity existed between the proposals for Operational Bills and Builders Quantities, it was found that the quantities for the Operational Bills were the net quantities of the completed construction. This was a fundamental difference to the Builders Quantities, these latter reflected the gross quantities of the resources required to undertake the works. The Builders Quantities were measured by, or on behalf of, the contractor not by the clients representative as the Operational Bills were. Again, a fundamental difference.

The BRE also undertook research into controlling wastage on construction sites. Papers published detailing this work were:

'Wastage of Materials on Building Sites' by E R Skoyles and H J Hussey;
'Site Accounting for Waste of Materials' by E R Skoyles;
'Resource Inputs to New Construction (Hospital Buildings) by J Lemmasany and M A Clapp;
'Information Systems Relating to the Construction Industry' by A Gilchrist and Kathleen Gaster.

Again, discussions about this work were held with two authors, E R Skoyles and H J Hussey. The research concentrated on the development of packaging and recording systems to aid the reduction of material waste on site. The research required for the development of Builders Quantities required waste to be measured or assessed prior to the usage on site, ie for anticipation rather than prevention or control.

Other research undertaken by the BRE but unpublished was discussed with Mrs Iris Addison and Mr Alan Stevens and is documented in Appendix D.

4.4 ROYAL INSTITUTION OF CHARTERED SURVEYORS

The Royal Institution of Chartered Surveyors were very involved in the measurement of quantities for the construction industry and were, along with the then National Federation of Building Trade Employers (NFBTE), producing the Standard Method of Measurement of Building Works : Sixth Edition, 1979 and the Seventh Edition 1988 with the Building Employers Confederation (formerly the NFBTE).

The RICS Standard Method of Measurement (SMM) was first published in 1922, having been developed by the Joint Committee of the Surveyors' Institution and the Quantity Surveyors' Association and four contractor members of the NFBTE. The first SMM was produced as a result of frequent disputes regarding the measurement of building works. It was recognised by the two surveying bodies that the lack of uniformity in the method of measuring building works for the production of Bills of Quantities frequently left the contractors' estimator in doubt as to what was required and "militated against scientific and accurate tendering" $^{(9)}$

It was clear from this statement that the main objective for Bills of Quantities prepared using the SMM was for tendering which resulted in the BQ becoming a contract document used for the valuation of variations and interim payments.

In order to price Bills of Quantities measured in accordance with the SMM, the contractors' estimator must allow for all the "deemed to be included" items. An examination of the SMM6 Clauses revealed the extent of items deemed to be included and were summarized as follows:

SMM 6

Section A - General Rules

A.3 Measurement

Point 2 states "Work shall be measured net as fixed in position", therefore the estimator must make allowances for the gross resources required to arrive at the completed work.

A.4 Descriptions

Point 2 gives a list of what is deemed to be included with all BQ measured items as follows:

- "a. Labour and all costs in connection therewith.
- b. Materials, goods and all costs in connection therewith.
- c. Fitting and fixing materials and goods in position.
- d. Plant and all costs in connection therewith.
- e. Waste of materials.
- f. Square cutting.
- g. Establishment charges, overhead charges and profit."

The four main areas mentioned, ie <u>labour</u>, <u>plant</u>, <u>materials</u> and <u>overheads</u> and <u>profit</u>, were all found to be the subject of separate post-contract management function tasks, procured from different sources, invoiced and paid for separately. It became immediately obvious that a considerable amount of reworking of data was required for the post-contract management of the resources.

The "deemed to be included" clauses apply to all the works, they may be further defined within the measurement rules relating to a particular trade or work section. For example:

Section D - Excavation and Earthwork

Point D.12.2 describing the measurement of excavation and filling of working space requires that

"Additional earthwork support and disposal or surface treatment arising from the measurement of working space shall be deemed to be included."

Therefore, it could be seen from an examination of the RICS SMM that the contractors' estimator was required to allow for many items not described or

measured in the Bills of Quantities. Most of these items, particularly for the material resources, needed to be quantified at some point to be ordered or bought by the contractor for incorporation into the works. This resulted in the need for the contractor to re-measure and re-work measured quantity data during the post-contract management.

In 1988 SMM6 was superceded by SMM7. However, the "Generally" clauses previously mentioned, were incorporated unamended. The amount of work deemed to be included for working space was, incidentally, substantially increased. The underlying principles of the use of the document, as far as the contractors' management functions were concerned, in that re-measurement and re-working were required, remained unchanged. The main changes from SMM6 to SMM7 were in the format (from portrait to landscape) and the alteration of trades to work sections. These work sections were compatible with the standard documents under the convention of Co-Ordinating Committee for Project Information, whose main objectives were to improve the documentation and procedures for design. As such, these objectives did not seek to amend the measurement rules substantially although the number of measured items included in the Bills were intended to be reduced by increasing the amount of work "deemed to be included." These reductions took the form of omitting measurement of individual minor labours. However, some changes to the measurement rules themselves were made. Most notable of these was the measurement of working space to excavation which was amended from cubic metres representing the volume of space to square metres representing the face area of the work requiring working space. It could be seen from this example that the change in the unit measurement resulted in the estimator being required to assess the following:

- (a) the volume of excavation and backfilling to give labour and plant;
- (b) the additional earthwork support (over and above that measured to the face of the excavation) for labour, plant and materials.

These items were assessed without quantities from the client.

SMM7 was reviewed in the Chartered Quantity Surveyor by Strotton. The following were points of interest in the article:

"It has been said that this new format is to assist tendering contractors when separating bills into the many subcontract packages which exist in building contracts today. To some extent I believe that this has been achieved but at the cost of fragmentation of areas of work."(10)

The result of this fragmentation appeared to be the measurement of similar work in more than one section, plaster board being an example cited in the CQS article. It is possible that this duplication in the measurement rules could lead to a lack of uniformity in the measurement of building works which was contrary to the intentions of the first edition of the Standard Method of Measurement.

Strotton also observed that the intended reduction of measured items by deeming many labours included, was counteracted by an increase in the number of work sections.⁽¹¹⁾

It was further observed by $Strotton^{(12)}$ that the meaning of the term "deemed to be included" appeared to be altered from the traditionally accepted definition in that, under SMM7 general rule 2.11, materials previously "deemed to be included", eg incidentals, were to be specifically included in the item description. It was felt that this would substantially increase the length and complexity of the item description. This could, in turn, have led to differences between the various tender documents.

Strotton concludes his review of SMM7 with a belief that SMM7 still had not entirely fulfilled the SMM development unit brief.

That the RICS Standard Method of Measurement falls short of ideal was illustrated by the frequency of its revision, with seven editions 1922 - 1988 in periods of less than ten years.

4.5 THE BRITISH PROPERTY FEDERATION

The British Property Federation (BPF) comprising of property owning organisations, including Marks and Spencer PLC, St Martins Property Land Securities, Brixton Estates, Norwich Union, researched and developed an alternative method for the procurement and organisation of the building process. This method was launched in December 1983 as the BPF System for Design and Construction. Many of the conclusions of the BPF System development team were found to be applicable to the research into 'Builders Quantities' as the aims stated in the Manual of the BPF System⁽¹³⁾.

- "to remove as much as possible of the overlap of the effort between designers, quantity surveyors and contractors which prevail under the existing system;
- to re-establish awareness of real costs by all members of the design and construction team;
- to eliminate practices which absorb unnecessary effort and time and obstruct progress towards completion";

confirm the findings of the other research reviewed in this Chapter.

Under the BPF System, the traditional Bills of Quantities were replaced by Schedules of Activities prepared and priced by the contractor, by which the contractor is paid as and when activities are completed.⁽¹⁴⁾ This move was supported by Wakefield (Chairman, Y J Lovell PLC) who felt that traditional Bills of Quantities directly encouraged inefficiency in the construction process.⁽¹⁵⁾

This was an expression of dissatisfaction with existing, traditional procurement methods and Bills of Quantities in particular. Therefore, Bills of Quantities were viewed by some clients to fail to fulfil a useful function. The provision of activity schedules allowed the contractor to arrange data to suit his particular construction method. The arrangement of data also allowed the contractor to control interim payments from the client. This was the opposite to the traditional situation with Bills of Quantities, where the Bills dictated the arrangement of interim payment and the Bills were compiled by the client's representative.

No suggestions were made by the BPF as to how the activity schedules could be prepared or what format they would take. This was left to the discretion of the participating contracting companies. It was claimed by Tyler during the presentation of a paper at the RIBA/CICA conference (16) that one finding of a research project undertaken at Loughborough University of Technology was that contractors working with the BPF system prepared traditional Bills of Quantities instead of taking advantage of an opportunity to prepare a document to aid production. A need for some measurement rules or guidelines was identified for use with the BPF system for the preparation of activity schedules.

4.6 THE CHARTERED INSTITUTE OF BUILDING

The Chartered Institute of Building has published two documents that relate to the research into Builders' Quantities:

- Code of Estimating Practice, 5th edition;
- The Contractor's Use of Bills of Quantities.

The Code of Estimating Practice identified estimating as a separate function from tendering and the links between the functions of estimating and programming buying and construction. The Code requested that these links across the management functions were not underestimated in their importance⁽¹⁷⁾.

The Code stated that an estimate required each operation or item to be analysed into its simplest elements and the cost estimated methodically on the basis of factual information⁽¹⁸⁾. This ensured sound estimating practices and estimates.

The Code recognised that the preparation of a method statement early in the estimating sequence was essential and gave a list of points to be considered when preparing a method statement⁽¹⁹⁾. The main purposes of the method statement were identified as:

- to establish the principles on which the estimate was based;
- to acquaint construction personnel of the resource limits which were allowed for in the estimate; and
- to describe the method of working envisaged at tender stage $^{(20)}$.

Also contained in the Code were specimen pro-formas for documenting cost information for the resources of labour, plant, materials and sub-contractor. These pro-formas required a detailed breakdown of the individual resources and the information given provided a good basis for post-contract management. Copies of these pro-formas were included in Appendix C.

Operational estimating was considered in the Code as a method of calculating a unit rate for inclusion in Bills of Quantities. In the example used to illustrate operational estimating, various method statements were considered in detail before the extent of the operation was decided⁽²¹⁾. Operational estimating considered the inter-relationship of trades involved in construction although the data used in the cost breakdown⁽²²⁾ was worked into a composite unit rate for labour, plant and materials.

The CIOB Code of Estimating Practice outlined the considerations and procedures for estimating for tendering purposes. As such it outlined the resources required for construction work but made no observation, or recommendation, regarding the method of measuring the quantities of these resources. Therefore, although there appeared to be some overlap in the research for the Code and Builders' Quantities it was more a case of building upon the Code of Estimating Practice to develop a method of preparing suitable quantities for estimating and for use during the post-contract management of the construction works.

Some research had been undertaken into the use of quantity data by Skinner at Aston University, Birmingham. This work was published by the CIOB as Occasional Paper No. 24, The Contractor's Use of Bills of Quantities in 1981. The work examines the history of the RICS Standard Method of Measurement and its use for the preparation of Bills of Quantities. The study recognised that Bills prepared using the SMM were not amenable to amendment which would enable contractors to relate site costs to bill prices⁽²³⁾.

The prime objectives of Skinner's work were to examine in detail how a contractor used Bills of Quantities and to assess that usefulness⁽²⁴⁾. Therefore the direction of this work was the identification of the tasks for which Bills were used rather than where they were of little or no use. This latter was the direction of the work for Builders' Quantities. There was some overlap in the studies in the observation of tasks undertaken for the management of the construction process. The major conclusions of Skinner's work were that Bills of Quantities were not ideally suited to the needs of tendering and production⁽²⁵⁾ as they did not allow consideration of time and method⁽²⁶⁾. This resulted in a need for a document that took account of production⁽²⁷⁾. These conclusions were of major significance to the research for Builders' Quantities as they supported the hypothesis.

4.7 CONCLUSION

The major conclusion drawn from the literature review was that although much work had been undertaken which examined Bills of Quantities, their use and alternative formats, <u>none had been</u> undertaken which attempted to reflect the data requirements of the contractors management and production of the construction work. The literature survey revealed that the problems of data use for production and management were established and thus supported the work undertaken for Builders Quantities.

CHAPTER FIVE

APPRAISAL OF EXISTING DATA AND USES

- 5.1 Introduction
- 5.2 Existing Tender Documentation
- 5.3 Examination of Traditional Bills of Quantities
- 5.4 RICS Standard Method of Measurement
- 5.5 Content of Traditional Bills of Quantities
- 5.6 Accuracy of B/Q Measured Data
- 5.7 Advantages and Disadvantages of Client Originated B/Qs
- 5.8 Contractors Data Requirements
- 5.9 Shortfalls of Traditional Bills of Quantities
- 5.10 Definition of Data and Measured Data
- 5.11 Definition of Tasks Performed
- 5.12 Definition of Management Function Groups
- 5.13 Definition of Cost and Price
- 5.14 Conclusion

CHAPTER FIVE

APPRAISAL OF EXISTING DATA AND USES

5.1 INTRODUCTION

ì

)

This chapter starts by examining the measured quantity data supplied to the contractors estimator by the client in the tender documentation. It was deemed necessary to examine this documentation as it provided the contractor with the first details of the proposed construction work and, if the tender was successful, became the contract documentation. A survey of the existing measured quantity data formed a logical first step in the research along with a literature survey.

Data described and analysed in this chapter, unless referenced otherwise, was collected by interview during the case studies and from discussions with experts, and are documented in more detail in Appendices B and D. The data collected regarding the existing tender documentation and Bills of Quantities in particular was presented at two construction conferences and the paper published (vide 12.5).

The survey for the existing documentation allowed definitions of data, management tasks and management functions to be drawn up which, in turn, formed the basis of the study revealing the contractors requirements regarding measured quantity data.

This chapter aims to detail existing data and practices and shortfalls in these, as identifed by the requirements of the contractors.

5.2 EXISTING TENDER DOCUMENTATION

During the three case studies (vide Appendix B), it was noted that the tender documentation used were either:

i) Lump sum contracts with Bills of Quantities; or

ii) Lump sum specification and drawing contracts i.e. without quantities.

This tender documentation, observed within each of the three organizations, was prepared by the clients design team. However, personnel from the participating contracting organisations stated that a third form of tender was used and this was a design and construct tender which required the contractor to supply a design for the Following the review of SMM7 by $Strotton^{(28)}$, a paper prepared by McCaffer and Pasquire⁽²⁹⁾ outlined the shortfalls of the existing method of measurement and identified the need for an alternative method (vide Appendix F).

Indirect feedback about the theories on builders' quantities received from anonymous referees for articles (vide Appendix F) and funding applications (vide Appendix A) has revealed that a body of opinion exists that asserts the RICS SMM7 already fulfills the requirements for post contract data use by contractors. The contracting personnel questioned felt, however, that quantities prepared by the client's representative had little use outside the tender preparation..

5.5 CONTENT OF TRADITIONAL BILLS OF QUANTITIES

|| Traditional Bill of Quantities comprised of four main sections:

- (i) The preliminaries described any contract requirements not forming part of the finished construction works. These incedental factors included:
 - the form of contract to be used;
 - access to the site;
 - any temporary works and accommodation required;
 - health and safety requirements;
 - insurances; etc.
- (ii) The preambles described the standards of workmanship and materials to be incorporated into the works.
- (iii) The measured items of construction works which included the following:
 - a) The written description of the item of construction works. This was usually a description of a finished item of work based on the type of material incorporated into the building or, in the case of excavation, the material removed. In each case, no description of the utilisation of labour or plant was given nor any details of the method of achieving the works. These latter were deemed to be at the discretion of the contractor.

These descriptions were then grouped into the B/Q in sections. Two commonly used formats were:

- i. by trade trade being a particular labour skill such as bricklaying, woodworking, concreting etc; or
- ii. by trade within elements element being a section of construction for example: external walls, roof, floors etc.

The most popular and commonly used, of these formats was found to be the traditional trade bill where all descriptions of works undertaken by one trade e.g. bricklayer or carpenter, were grouped together in a single trade Bill.

- b) In each case the description carried with it a unit of measurement. These units were:
 - i. linear metres;
 - ii. square metres;
 - iii. cubic metres; or
 - iv. number.

Some descriptions were not quantified but described as "item".

Some indication of length/width/height of the described construction work, whether quantified or measured as "item", was given in the written description where appropriate e.g. a square metre item contained a depth in the description.

c) Every described item within the Bill was allocated a quantity of measured units. This quantity was measured off the drawings and represented the net quantity of material incorporated into that item of construction or, in the case of excavation, the net quantity of material removed. No allowance was made for wastage, bulking or compaction of the material and these were considered a contractors risk item. Therefore, when preparing an estimate the contractor attempted to quantify and price these risk factors not only for the material resource, but also for the labour and plant resource. This confirmed McCaffers' original argument that Bills of Quantities were seldom accurate and when examined further, put the usefulness of traditional B/Qs as any kind of management tool in doubt.

iv) The provisional and prime cost items where sums of money were set aside for expenditure at a later date. No quantities were given and the extent of the work may or may not have been known at the time of tender. These provide a further example of inaccuracies in Bills of Quantities.

5.6 ACCURACY OF B/Q MEASURED DATA

It was argued by McCaffer and Pasquire in the second report to SERC⁽³⁰⁾ on Builders' Quantities and in the paper "Bills of Quantities - Are they needed?"⁽³¹⁾, that there was no such thing as an exact cost for building works. This was illustrated by variations in initial tender prices although projects were tendered on identical information such as the B/Q. Even when an item of work had been completed it could not be said that costs incurred were the only correct permutation. The use of, for example, a different bricklaying gang, a slightly different construction method or even something as simple as a warmer/cooler day may result in different costs. Therefore, even historic cost data was not accurate in a scientific sense, the chances of the exact factors contributing to a particular historical cost actually re-occuring were very slight. Given this point of view, it was argued by Pasquire in the paper "Bills of Quantities - Are They Needed?"⁽³²⁾ that the existence of a B/Q which was "scientific and accurate", even for tender purposes, was unlikely.

5.7 ADVANTAGES AND DISADVANTAGES OF CLIENT ORIGINATED B/QS

The inexact nature of the cost of construction works was not the only consideration when examining the role of B/Qs and their usefulness. There were other, more generally accepted advantages and disadvantages in the preparation and use of $B/Qs^{(23)}$.

The advantages and disadvantages of using B/Qs to the various parties to the contract were outlined in Conference Papers presented by Tyler and Pasquire "Bills of Quantities - Are They Needed?" (vide 12.5 and Appendix F). These advantages and disadvantages were summarized as follows:

| The Client/Design team

The use of B/Qs had several advantages for the client. These included:

- competitive tendering by several contractors undertaken on an equal basis, therefore the client was safe in the knowledge that all tenders received included prices for the same description/quantity of work;
- the preparation of B/Qs during the design process aided the pre-contract cost-planning function, culminating in a pre- tender estimate based on the tender Bills; and
- during the post-contract stage, the Bills provided <u>pre-agreed basis</u> for the preparation of interim valuations; pricing variations both for valuation purposes and post-contract cost budgeting; and for the preparation of the final account.

The use of B/Qs had some disadvantages for the client however, for example:

- the preparation of B/Qs was a slow process;
- they were expensive to produce; and
- the design had to be reasonably complete if the quantities were measured and the B/Qs produced in accordance with the RICS standard method.

All these combined to make the pre-contract design period a protracted and costly process. There was another disadvantage to the client in the use of B/Qs which was not often considered. As the B/Qs did not normally reflect the cost of the work in relation to its location within the construction, valuations based on the Bills may not reflect the true value of the works executed. For example, as a general rule of thumb, the construction works became more expensive the further away from ground level (either above or below) they were. Therefore, the valuation may be too great for the works at or near ground level and insufficient for work at, say, eaves level.

This inherent defect in B/Qs left the pricing of items open to a degree of manipulation by some contractors. Practices such as "front loading" and inflated prices for items known to be undermeasured and vice versa, were examples cited by the contractors' personnel during the case studies (vide Appendix B). This manipulation of prices could be a severe disadvantage to a client particularly if the contract was determined.

The Contractor

It was observed during the case studies documented in Appendix B that Bills of Quantities prepared by the client were, on the whole, of little use to the contractor with one exception.

The ease with which B/Qs were split up and sent to domestic sub-contractors for tendering purposes without taking up too much of the main contractor's time was deemed to be an advantage. The main contractor then benefitted from all the advantages listed for the client above, without the disadvantages of the lengthy and expensive preparation process. This situation however, only had the effect of passing the problems experienced by main contractors when using client prepared Bills to the sub-contractor. These problems were discussed with contractors' personnel during the case studies (vide Appendix B) and were outlined as follows:

it was found estimators preferred to price B/Qs. They could use the same unit rates from job to job, they were familiar with the meaning of the various SMMs and could look up measurement rules that had been adapted from these by various clients e.g. the "not withstanding" clauses commonly used by central and local government offices. This was initially seen as an advantage as tenders could be produced quickly, allowing more contracts to be tendered for thus increasing theprobability of gaining orders. But, when examined in the light of the recommendations for estimating laid down in the CIOB Code of Estimating Practice, it was seen that repeating the use of unit rates without due care compounded inaccuracies already incorporated into the B/Q by the method of measuring and describing the works and ignored the recommendation that consideration be given to implications of constructing each individual project. This resulted in the client and against the objectives of the BQ) by undertaking carelessly priced projects.

the estimators interviewed claimed that the B/Qs prepared by the client contained measured data referring to the finished structure, leaving the contractor to provide his own documented breakdown of the resources required to construct these works. The measured data in the clients' Bills was described by the type and net quantity of materials used with a small amount of detail referring to special labours. The emphasis on the incorporation of the materials into the works was misplaced. The cost of the materials alone carried little risk and had little effect on the cost of the works. For example: the cost for the supply of bricks did not vary in relation to their location in the structure, however, the cost of fixing or "laying" those bricks varied considerably in accordance with their location.

It was seen therefore that, for an estimator to ensure that the total cost of resources used during the construction works was adequately allowed for in the tender, he was required to compile a secondary document which supplemented the information provided in the clients' Bills. This document reflected decisions made by the estimator about the method of working for each tender along with breakdowns of the labour, plant and material resources required to complete each item of works described in the bill. This data was often measured in different units to those in the B/Q and some conversion of the figures was required to present the costs in the B/Q format.

It was further observed during the case studies (vide Appendix B) that this reworking and adaptation was continued to a greater degree throughout the post-contract management of the works. It was thought that this could be reduced where the estimators' data was prepared in a format that allowed these post-contract managers to pick out the information they required to carry out their functions without substantial regeneration and reworking of data.

The contractor's purchasers required information about the gross quantities of materials to be bought. Some conversion of estimators' data was required if materials were not detailed in their buying units or no account had been taken of standard lengths, sheet sizes or minimum quantities in standard packs i.e. "buying waste" (as opposed to "usage or breakage waste").

The contractor's surveyors experienced difficulty when compiling labour and plant budgets/targets from B/Q data, as these were expressed in operations or activities and given to the site as a price for the labour or plant resources. This price was a target which the site manager attempted to beat or stay within when negotiating with labour only sub-contractors and by which he certified weekly labour payments for directly employed labour. He used the plant budgets to judge what items of plant were to be used and for how long. The items of plant actually used were not always the ones described in the plant schedules, as the actual method of working may be different to the one assumed by the estimator. But, ultimately, the money available for the labour and plant resources could not be increased from that

allowed for by the estimator. This reinforced the need for caution on the part of the was that what for that perposer estimator when pricing the clients B/Q.

could

Landericad

ler

The B/Q was observed to be a totally unsuitable tool for planning and executing the works. In the first instance the site manager, foreman or agent rarely allocated or directed the workforce by reference to the measured items in the B/Q. The sequence of construction was taken from the working drawings. It was also argued that the scientific and accurate nature of the clients B/Q did not reflect the complex and intricate juggling of available resources that formed the day-to-day management of a site. A constant check was kept on the site stock of materials and "another load" ordered in line with the site managers judgement of the speed of use and quantity remaining to be incorporated. The labour force was sent where it was needed when it was needed, and both of these tasks combined to complete the works in the shortest possible time.

5.8 **CONTRACTORS DATA REQUIREMENTS**

It was further observed during the case studies and documented in Chapter 6, that the contractor required and used a great deal of detailed quantity data regarding the resources used throughout the construction works and of how these resources were used and allocated during the contract period. The contractor needed to see this resource allocation and reduce the costs included for in the tender during the execution of the works. Therefore, recommendations for the preparation of builders' quantities for contractors must be flexible enough to be used by all the management functions involved with the contract and reduce the time spent on converting, reworking and generating data within each. It was the definition of measured data requirements and uses by the varying sections within construction organisations that formed the basis of this research and the framework for the definition of a set of measurement rules for Builders' Quantities.

The observation of the use of quantities within the contracting industry undertaken during the three case studies revealed that contractors had a great need for quantitative data.

That existing forms of measured quantity data were unsuitable was illustrated by:

a) the increasing use of tender documentation prepared by the client without quantities and

b) the development of several alternative methods of preparing tender documentation undertaken during the 60 years since 1920. Most notably the BRE operational billing system and the BPF system (vide supra 4.4 & 4.6). The extent of research into alternative methods suggested that the existing method advocated by the RICS was falling short of the industrys' requirements. The frequent amendment of the RICS SMM itself (seven editions in 66 years) suggests that they were not happy with the document either (vide supra 4.5).

5.9 SHORTFALLS OF TRADITIONAL BILLS OF QUANTITIES

The main areas of the contractors disatisfaction with traditional Bills of Quantities were identified during the case studies (vide Appendix B) as follows:

- (a) The principle of measurement for traditional B/Qs was based on the measurement of the net material content of the completed works. The contractors' personnel interviewed felt that this emphasis was incorrect. The labour resource was felt to be more important even where the total material cost formed a large percentage of the overall contract cost because more risk to the contractor was contained in the labour resource. By formatting the measured data around the material content, the labour resource was being fragmented into several measured items requiring much reworking of data, both at pre- and post-contract stages as a single labour item may incorporate a variety of materials.
- (b) Basing the measurement on the material content did not allow the effect of location to be reflected in the cost. The base cost of the material was not affected by its location within the construction. However, the implication of the location on the labour resource could be quite extensive.
- (c) Varying the format of the B/Q in an attempt to reflect location was also unsuccessful, adding fragmentation of the material resource to the already scattered labour.
- (d) The quantities of materials measured bore little relationship to the quantities actually required. Hence the contractor advised not to order materials from the Bill quantities. In each case the labour content of an item was "deemed to be included". Therefore, starting with an inaccurate measurement of the material resource, the allocation of the other contract resources required for

that item compounded the inaccuracies and could not be said to reflect the works.

(e) Data regarding the actual use of resources and expenditure received from the site reflected the construction sequence and substantial reworking of data was required to ensure that the income, expressed in a traditional B/Q format, adequately covered the expenditure. It was found that the method of working sometimes involved items of work not detailed in the B/Q and vice versa. These variations do not constitute variations under the contract for which a claim could be made and illustrate the mis-match between the tender/contract data and the actual resource usage data which has to be overcome by the contractors management personnel.

The result of these shortfalls in the data contained in B/Qs involved the contractors management functions in splitting and re-allocating resources followed by re-aggregation into notional items of work contained in the B/Q if any sort of cost monitoring and data management was to be successful.

5.10 DEFINITION OF DATA AND MEASURED DATA

In order to proceed with the research it was necessary to identify and define the data being studied.

For the purposes of this research the terms "data" and "measured data" were defined from observations made during the case studies as follows:

- (a) Data referred to the contract specific information regarding works undertaken by the contractors directly employed labour or labour-only subcontractors.
- (b) Measured data referred to the quantities of resources and all associated descriptions compiled prior to and during the works in order to anticipate, plan and procure the actual resource requirements.

Large quantities of information were observed during the case studies for use by the management personnel. Because the contracting companies were commercial organisations, not all of this information referred to construction and contracts (methods and resources), a proportion of available information referred to the various business management functions, for example marketing, personnel (welfare, promotion, etc). This information was found not to be generally used by the personnel involved in construction contract procurement and management and was excluded from the scope of the research although the existence of such departments must be allowed for in the company overheads. The remaining information was all construction or contract related but was split into two categories, information relating to general construction and contract matters and that concerning specific contracts. Examples of the two types of information were summarised as follows:

(a) Company general

- invoices, time sheets, etc. for company accounting and book-keeping functions;
- suppliers current price lists;
- technical information from suppliers and specialist sub-contractors;
- company expenses and overheads;
- current and anticipated workloads; and
- location and availability of labour, plant and materials.

This general information was available within contracting organisations most of the time and the management personnel kept any general data required to hand. This data could then be applied to specific contracts as appropriate.

- (b) Contract specific
 - tender/contract documentation;
 - scope of the works;
 - client type;
 - itemised and/or quantified descriptions of the works;
 - costs incurred by the contractor;
 - prices charged to the client;
 - quantities of resources, anticipated and actual;
 - invoices and time sheets;
 - correspondence with client, suppliers and sub-contractors; and
 - variations to the contract.

The contract specific information was further split into:

Information relating to site works undertaken by directly employed labour
 or labour only sub-contractors; and

(b) Information relating to sub-contractors.

This split in contract specific information was observed throughout all the management functions in the three contracting organisations studied. Sub-contracts (domestic and nominated) were managed as a single commodity with little reference to measured data. A portion of the works were defined as being a "sub-contract" and, in the absence of client prepared quantities, any measured data was generated by the sub-contractor. The only instance where the main contractor prepared measured data for sub-contractors occurred when these quantities were prepared by private practice quantity surveyors on the main contractor's behalf. Although this measured data was monitored by most of the main contractors management personnel, little manipulation or transformation occurred unless substantial variations and/or re-measurement of the completed works were required. The majority of measured data preparation, transformation and manipulation was found to occur during the procurement and management of in-house resources or those relating to works undertaken by directly employed labour or labour only sub-contractors.

5.11 DEFINITION OF TASKS PERFORMED

After defining the data, it was then necessary to define the use to which this data was put by examining the tasks performed by the management personnel.

Whilst the tasks performed and the methods of achieving these tasks were similar within the participating contracting organisations, it was found that these tasks were delegated to differing management functions from company to company. Consequently the tasks performed were defined before any use of data was is examined. The tasks undertaken were grouped into the following task categories:

- (a) measurement of quantities for tender purposes.
 - (i) to supplement client prepared quantitative data; or
 - to provide quantitative data where none supplied by the client e.g.
 design/construct or specification and drawing tenders.
- (b) to assess the resource costs and allocate to the quantities to produce the tender;
- (c) to obtain sub-contract tenders for the appropriate works;

- (d) to price the preliminary items, Prime Cost and provisional sums;
- (e) to assess and allocate the additional overhead and attendance costs and add a profit element to (b), (c) and (d) above (herein after called the "margin");
- (f) to schedule the materials for ordering purposes;
- (g) to compile a time based programme for the construction works (the format of programme varied between contractors);
- (h) to order the materials and instruct sub-contractors in line with the programme for the works;
- (i) to allocate the labour and plant resources required for the construction works in line with the programme;
- (j) to prepare budget/target costs and monitor the contract profitability from actual use of resources;
- (k) to monitor the progress of the works on site;
- (1) to prepare and submit interim valuations for completed works;
- (m) to accommodate variations to the works; and
- (n) to prepare and submit the final account and assess actual profit.

The allocation of these tasks to the management personnel observed within the contracting organisations participating in the case studies are illustrated in Tables 5.1, 5.2 and 5.3 on the following pages.

5.12. DEFINITION OF MANAGEMENT FUNCTION GROUPS

Having identified the tasks performed, these tasks were allocated to a management function most frequently found to undertake that task, in order to structure the documentation of the interchange and use of data and provide a framework within which to define the measurement rules.
TASK PERFORMED	MANAGEMENT FUNCTION	
 Measuring the quantities for tender purposes: to supplement quantitative tender documentation to provide quantitative data where none supplied by Client, eg design/construct specification/drawing tenders 	Estimator - prepares gross quantity of each resource used. Private practice quantity surveyor - measures quantities off drawings/design brief for pricing purposes.	
2) Obtain quotes from sub-contractors.	Estimator	
3) Price the quantities to produce the tender	Estimator	
4) Price preliminary items, PC and provisional sums	Estimator - may seek advice from site management.	
5) Assess percentage addition for profit and overheads.	Estimator - may seek advice from higher management	
6) To schedule the materials for ordering	Purchaser.	
7) Place orders with sub-contractors.	Purchaser - may obtain further quotes.	
8) Compile time based programme for the works.	Planner - may seek advice from site manager and/or purchaser.	
9) Order materials in line with programme.	Purchaser - may seek advice from site manager.	
10) Allocate labour resources in line with programme.	Site manager.	
11) Prepare target costings and monitor profitability.	Surveyor - may seek advice from site manager and higher management.	
12) Monitor progress on site.	Site manager - may seek advice from higher management.	
13) Prepare interim valuations.	Surveyor - may seek advice from site manager.	
14) Accommodate variations.	Purchaser) Planner) may seek advice from Site manager) higher management. Surveyor)	
15) Prepare final account.	Surveyor - will report to higher management.	

•

TABLE	5.1	- Tasks	performed by	management	functions -
			Case Study	Α -	

TASK PERFORMED	MANAGEMENT FUNCTION
 Measuring the quantities for tender purposes to supplement quantitative tender documentation to provide quantitative data where none supplied by Client, eg design/construct specification/drawing tenders 	Estimator - prepares gross quantity of each resource used. In-house quantity surveyor measures quantities off drawings/design brief for pricing purposes.
2) Obtain quotes from sub-contractors.	Estimator
3) Price the quantities to produce the tender	Estimator
4) Price preliminary items, PC and provisional sums	Estimator - may seek advice from site management.
 Assess percentage addition for profit and overheads. 	Estimator - may seek advice from higher management
6) To schedule the materials for ordering	Purchaser.
7) Place orders with sub-contractors.	Purchaser - may obtain further quotes.
8) Compile time based programme for the works.	Planner - may seek advice from site manager and/or purchaser.
9) Order materials in line with programme.	Purchaser - may seek advice from site manager.
10) Allocate labour resources in line with programme.	Site manager.
11) Prepare target costings and monitor profitability.	Surveyor - may seek advice from site manager and higher management.
12) Monitor progress on site.	Site manager - may seek advice from higher management.
13) Prepare interim valuations.	Surveyor - may seek advice from site manager.
14) Accommodate variations.	Purchaser) Planner) may seek advice from Site manager) higher management. Surveyor)
15) Prepare final account.	Surveyor - will report to higher management.

-

.

TABLE 5.2 - Tasks performed by management functions -Case Study B

.

TASK PERFORMED	MANAGEMENT FUNCTION	
 Measuring the quantities for tender purposes to supplement quantitative tender documentation to provide quantitative data where none supplied by Client, eg design/construct specification/drawing tenders 	Estimator - prepares gross quantity of each resource used. Estimator - measures quantities off drawings/design brief for pricing purposes.	
2) Obtain quotes from sub-contractors.	Estimator	
3) Price the quantities to produce the tender	Estimator	
 4) Price preliminary items, PC and provisional sums 6) Access addition for a second state of the sec	Estimator - may seek advice from site management.	
profit and overheads.	Estimator - may seek advice from higher management	
6) To schedule the materials for ordering	Purchaser.	
7) Place orders with sub-contractors.	Purchaser - may obtain further quotes.	
8) Compile time based programme for the works.	Planner - may seek advice from site manager and/or purchaser.	
9) Order materials in line with programme.	Purchaser - may seek advice from site manager.	
10) Allocate labour resources in line with programme.	Site manager.	
11) Prepare target costings and monitor profitability.	Surveyor - may seek advice from site manager and higher management.	
12) Monitor progress on site.	Site manager - may seek advice from higher management.	
13) Prepare interim valuations.	Surveyor - may seek advice from site manager.	
14) Accommodate variations.	Purchaser) may seek advice from Site manager) higher management. Surveyor)	
15) Prepare final account.	Surveyor - will report to higher management.	

TABLE 5.3 - Tasks performed by management functions -Case Study C

It was found that, although different tasks may be undertaken by the same personnel, the interfaces between the tasks remained consistent. This gave rise to a grouping of tasks between interfaces. This grouping is illustrated in Table 5.4 and each group has been called a management function.

The title given to each management function corresponds to the titles most commonly used by the contractors management personnel to describe their function. These titles were found to be:

- estimating;
- purchasing/buying;
- planning;
- surveying;
- site management; and
- higher management.

It can be seen from Table 5.4 that no task category was allocated to the higher management function. Although it was found that higher managers may undertake work in some of the task categories, the higher manager was deemed to be assuming one of the alternative function titles whilst undertaking these tasks. The tasks performed by the higher management function did not make a direct contribution to the procurement and management of a contract, rather, the higher management function initiated the impetus for the other functions to carry out their required tasks. This impetus was most usually manifested in the reports and supplementary information requested by the higher management functions on which company management decisions were then based.

5.13 DEFINITION OF COST AND PRICE

The use of the terms "cost" and "price" was observed frequently during the case studies and a clear definition of each term was made for the purposes of this research documentation. These terms were defined as:

Cost - the cost of the works was deemed to be that paid by the contractor. The cost comprised of the amounts paid by the contractor for the labour, plant and materials to suppliers and sub-contractors plus the financial outlay incurred by the main contractor for the use of the directly employed labour and contractor owned plant i.e. all costs directly attributable to the execution of the contract and are not incurred if the contract is not undertaken.

	TASK	FUNCTION
1)	Measuring quantities for tender purposes	
	 i) to supplement quantitative tender information; ii) to provide quantitative data where none supplied with tender. 	
2)	Obtain initial sub-contract quotes	ESTIMATOR
3)	Price quantities to produce tender	
4)	Price preliminary items, PC and provisional sums.	
5)	Assess percentage addition for profit and overheads.	
6)	Schedule materials for ordering.	
7)	Obtain extra sub-contract quotes.	
8)	Negotiate best deal with material suppliers in line with targets.	PURCHASER
9)	Place sub-contract and material orders in line with program.	
10)	Compile time based program and update with progress.	PLANNER
11)	Prepare resource cost targets and circulate to management function responsible.	
12)	Monitor resource expenditure against targets for profitability.	SURVEYOR
13	Prepare interim valuations and monitor contract cash flow.	
14	Prepare final account and final contract profit.	
15)	Allocate labour/plant resources in line with program and targets.	SITE MANAGER
16)	Monitor and report progress.	
17	Accommodate variations by repeating much of above.	ALL MANAGEMENT FUNCTIONS

TABLE 5.4 - Standardization of management tasks and functions

Price - the price of the works was deemed to be that charged to the client by the main contractor for the execution of the contract or parts thereof. This price included the "cost" of the works plus the contractors' margin for overheads and profit. The term price was defined as meaning any sum charged by a seller to a purchaser, therefore, a sub-contractors' "price" became the main contractors' "cost".

This research confined itself, in the main, to the measured data used by the main contractor to anticipate and control contract costs as defined above.

NOTE: indirect costs were those that were incurred by the contractor whether or not construction works were undertaken e.g. office salaries and rent, postage, stationary etc. Indirect costs were taken into account by the margin addition to the direct costs and as such did not form part of this research.

5.14 CONCLUSION

The survey of existing measured data and opinions of the management personnel of the contracting organizations participating in the case studies reguarding that data, and in particular measured quantity data supplied by the client, highlighted shortfalls in the available data. This shortfall showed that there was a need for data that would overcome this, thus fulfilling an important step described in the Methodology 3.

The existing management tasks and management functions have also been defined along with the data and measured data observed within the contracting organizations participating in the case studies. This then provided a basis from which to undertake the detailed analysis of the management functions and their individual uses of data documented in Chapter 6.

CHAPTER SIX: CONTENTS

DETAILED DATA STUDY WITHIN THE MANAGEMENT FUNCTIONS

6.1 Introduction

SECTION A : Estimating management function

- 6.2 Definition of the Estimating Management Function
- 6.3. Evaluation of the Estimating Procedures
- 6.4. Information used by the Estimator
- 6.5. Data received by the Estimator
- 6.6. Data generated by the Estimator

SECTION B : Purchasing management function

- 6.7. Definition of the Purchasing Management Function
- 6.8 Evaluation of the Purchasing Procedures
- 6.9 Information used by the Purchaser
- 6.10. Data received by the Purchaser
- 6.11 Data not used by the Purchaser
- 6.12 Data transformed by the Purchaser
- 6.13 Data generated by the Purchaser
- 6.14 Data passed on by the Purchaser

SECTION C : Planning management function group

- 6.15 Definition of the Planning Management Function
- 6.16 Evaluation of the Planning Procedures
- 6.17 Information used by the Planner
- 6.18 Data received by the Planner
- 6.19 Data not used by the Planner
- 6.20 Data transformed by the Planner
- 6.21 Data generated by the Planner
- 6.22 Data passed on by the Planner

SECTION D : Surveying management function group

- 6.23 Definition of the Surveying Management Function
- 6.24 Evaluation of Surveying Procedures
- 6.25 Information used by the Surveyor
- 6.26 Data received by the Surveyor
- 6.27 Data not used by the Surveyor
- 6.28 Data transformed by the Surveyor
- 6.29 Data generated by the Surveyor
- 6.30 Data passed on by the Surveyor

SECTION E : Site management function group

- 6.31 Definition of the Site Manager's Management Function
- 6.32 Evaluation of Site Management Procedures
- 6.33 Information used by the Site Manager
- 6.34 Data received by the Site Manager
- 6.35 Data not used by the Site Manager
- 6.36 Data transformed by the Site Manager
- 6.37 Data generated by the Site Manager
- 6.38 Data passed on by the Site Manager

SECTION F: Higher management function

6.39 Definition of the Higher Management Function

SECTION G : CONCLUSIONS

6.40 Conclusions

CHAPTER SIX

DETAILED DATA STUDY WITHIN THE MANAGEMENT FUNCTIONS

6.1 INTRODUCTION

The main purpose of the case studies (vide Appendix B) was to identify the tasks, management functions, data used, its uses and the reworking, transformation and manipulation of that data. The basic definitions were given in Chapter Five (vide supra 5.10, 5.11 and 5.12) and this chapter builds upon these definitions and documents in detail the findings of the case studies. The data study is described within each management function stating firstly what the function comprised then examining the data used, received, not used, transformed, generated and passed on.

The information for the detailed data study was collected by observation and interviews during the case studies, as described in the Methodology 3.4

A. THE ESTIMATING MANAGEMENT FUNCTION

6.2 DEFINITION OF THE ESTIMATING MANAGEMENT FUNCTION

The estimating management function observed in the construction organisations studied had a threefold purpose:

- (a) to establish the cost of the works to the contractor;
- (b) to assess the market conditions; and
- (c) to reconcile (a) with (b) to produce the tender price.

The estimator was defined as a reconcilliator, balancing the costs to the main contractor with the price charged to the client in order to win the tender and make a profit on the works. To assess the profit margin correctly, the information generated in preparing a tender must be sufficient to accurately assess the contractors costs based on the tender documentation provided by the client. This tender documentation later became the contract documentation if the contractor's tender was successful. In all of the contracting organisations studied, the estimator was only involved with the pre-contract tasks of tendering for the works. Discussions with the higher management functions revealed that there were no plans to involve estimators in post-contract duties although there was unanimous agreement that feedback of post-contract information to the estimator was desirable.

6.3 EVALUATION OF ESTIMATING PROCEDURES

In order to achieve the threefold purpose of the estimating function, the estimator was observed to undertake the following steps.

- (a) To establish the cost of the works to the contractor:
- (i) abstract from the tender documentation what information could be used without transformation, what required reworking, what could be ignored and what needed to be generated in order to compile the tender;
- (ii) convert the contractors method of working into the design requirements of the project;
- (iii) assess the resource requirements and costs for the works;
- (iv) transform the resource costs into the tender format; and
- (v) assess the effect the location of the site, working restrictions, insurance requirements and other preliminary considerations had on the cost of the works.
- (b) To assess the market conditions:
- (i) evaluate client type, eg Local Authority may have upper cost limit (yardstick);
- (ii) evaluate current market conditions, eg a depressed market will result in keen competition;
- (iii) evaluate the desirability of the contract. Not all projects are profitable ones, a higher tender may be more desirable than not tendering; breaking even or making a loss may be necessary for repeat business. This evaluation may be undertaken by higher management.
- (c) To reconcile (a) with (b):
- (i) in most cases observed, this reconciliation took the form of adding a margin percentage to the established costs to reflect the overheads

and allow for profit in line with market conditions. This percentage addition was subjected to adjudication by the higher management in consultation with the estimator, site manager and, sometimes, the surveyor.

(ii) in exceptional cases, usually depending on the desirability of the contract, a lump sum was added/deducted or the percentage addition greatly increased/decreased. This deviation from normal company policy was solely instigated by higher management and was a commercial decision not affecting or affected by measured quantity data.

6.4 INFORMATION USED BY THE ESTIMATOR

The information available to the estimator is listed in Chapter 5.11. The amount and quality of project specific information received from the client was determined by the type and format of the tender documentation (vide supra Chapter 5.2).

Of the estimating tasks included in the estimating management function and the steps undertaken listed in 6.3 a, b and c above, only those performed in order to establish the cost of the works involved the use of measured data. Assessing the market conditions and the margin to be added to the cost of the works was based on the company performance on previous contracts. The performance of the company as a whole was also taken into account when assessing the overhead costs, as such, these assessments were not based on measured data but on annual financial turnover and examination of these assessments are outside the scope of the research objectives.

Therefore, the information used for estimating purposes was defined as that information used to establish the cost of the works with particular reference to the use of measured data.

The use of this information was examined under the headings of data received and data generated.

6.5 DATA RECEIVED BY THE ESTIMATOR

The tender documentation: this may take many forms but three observed during the case studies were:

Bills of Quantities (B/Q) comprising:

- preliminary items concerning the contract, the site, working restrictions; temporary works and accommodation etc.
- preamble items concerning the standard of materials and workmanship to be used (not normally priced);
- measured items comprising description and net quantity of items of completed works;
- drawings from which the B/Q has been prepared; and
- provisional and prime cost sums.

Specification and drawings comprising:

- preliminary items as above, may be less detailed;
- preamble items as above, may be less detailed;
- an itemised description of the completed works, no quantities measured, usually composite descriptions of sections of the finished construction;
- drawings from which the specification was prepared; and
- provisional and prime cost sums.

Design and construct comprising:

- a design brief or performance specification outlining the particular user requirements of the client; and
 - outline or conceptual sketches may or may not be provided.

Other general company data may be incorporated into the tender such as labour constants, current unit rates, current suppliers prices, etc.

Using this data the estimator undertook the tasks described in chapter 5, Table 4. In doing so, much of this original data underwent a transformation and new data was generated.

6.6 DATA GENERATED BY THE ESTIMATOR

The estimator generated a priced tender document (the estimate) comprising of the following:

- Measured quantities where none were supplied by the client, the estimator prepared a list of materials, plant and labour quantities based on the tender drawings;
- Unit rate each unit of measurement was given a unit cost which, when multiplied by the total quantity of that item gave the total item cost;

Resource breakdown

- unit costs for labour including an allowance for wasted time;
- unit costs for plant including some assessment of standing time;
- unit costs for materials including an assessment of wastage;

Sub-contract quotes - for works that were to be wholly executed by a subcontractor, the estimator obtained one or more quotations from suitable sub-contractors;

Supplier quotes - for the supply of materials and goods incorporated into the works, particularly for one-off, made to measure or unusual items;

- *Preliminary costs* an assessment of the financial implications of the effect of the preliminary items contained in the tender documentation had on the contract;
- Margin an addition was made to the unit costs to allow for the company overheads and profit.

This generated data was used by the estimator to complete the form of tender returned to the client. Most of the data generated by the estimator was for the contractor's internal use. If the tender was unsuccessful, this data was archived or destroyed. If the tender was successful, the data generated by the estimator was passed on to the purchaser and the surveyor. The site manager and planner receive copies of the tender documentation (now the contract documentation) and a copy of any quantities the estimator may have prepared, but not necessarily priced.

Once the tender was accepted by the client, the unit rates were fixed. No additional money can be claimed if it is found during the post-contract

stages that insufficient was included in the tender. Therefore, the resource breakdown generated by the estimator should clearly show what monies have been allocated to which resources. A clear resource breakdown was one of the factors identified in the CIOB Code of Estimating Practice⁽³⁴⁾, as aiding the efficiency and accuracy of the estimating procedure.

۲

B. THE PURCHASING MANAGEMENT FUNCTION

6.7 DEFINITION OF THE PURCHASING MANAGEMENT FUNCTION

Observations of the purchasing management function made during the case studies also revealed a threefold purpose:

- (a) to identify the commodities to be purchased for the project;
- (b) to buy these commodities at the most favourable cost;
- (c) to ensure that the commodities were on site at the correct time.

The term "commodity" was used in this instance to describe any item purchased and covered both materials and goods supplied for incorporation into the works by the contractors directly employed labour or labour only sub-contractors and the services provided by a sub-contract. The service provided by a domestic sub-contractor included the supply of all necessary labour, plant and materials and, as such, was purchased as a single item or commodity.

The purchasers observed always purchased the materials and goods to be supplied. Where the sub-contracts were not let by the purchaser, this was undertaken by the site manager. For the purposes of achieving the aims of this research, it has been assumed that the purchasing management function buys all the commodities for the construction works, including placing orders for the domestic sub-contract works.

The purchaser was mainly involved with the post-contract management of the project, although the estimator was found to consult the purchaser about materials and any current sub-contract cost data held in the purchasing department. The higher management of one construction organisation, however, (vide Appendix D - Potter) had indicated that future company policy would require a greater degree of involvement by the purchasing management function in the pre-contract duties of preparing tenders.

6.8 EVALUATION OF PURCHASING PROCEDURES

In order to undertake the purchasing function detailed in 6.7 (a), (b) and (c) above, the purchaser was observed to undertake the following steps.

- (a) To identify the commodities to be purchased:
- (i) abstract from the contract documentation and estimate, the gross quantities of each material to be incorporated into both the construction works and any temporary works. This was undertaken by a detailed scheduling process and included checking the B/Q quantities, eg those under/over measured, included in the B/Q but not on the drawings and vice versa;
- (ii) abstract from the contract documentation the portions of work that were to be sub-let.
- (b) To buy these commodities at the most favourable cost:
- (i) abstract from the estimate the costs allowed by the estimator for each material;
- (ii) obtain further quotations from sub-contractors and suppliers in an attempt to reduce the cost included by the estimator and increase the company profit margin.
- (c) To ensure that the commodities are on site at the correct time:
- (i) the abstract or schedule of materials was divided into the following groups:
 - those for regular use throughout the contract period, usually
 large quantities without long delivery periods;
 - those for use at specific times during the contract period, again without long delivery periods;
 - those which have long delivery periods and need ordering prior to commencement of the works in order to be delivered in line with the programme; and
 - any other materials not falling into one of the above categories.
- (ii) any long delivery periods were noted due to their possible effect on the programme.
- (iii) orders were placed with the sub-contractors to carry out works as specified and on-site dates allocated.

There were also sundry material items which were kept either ex-stock or on permanent order at a regular supplier for use by the site, eg nails, screws, tying wire, etc. These items were called for by the site as they were required, either through the purchaser or direct to the supplier. In each case, the purchaser was responsible for the control and authorisation of payment.

6.9 INFORMATION USED BY THE PURCHASER

In addition to the general company data, the information used by the purchaser depended on the tender documentation received by the estimator and the supplementary information generated during the estimating process. The purchaser was observed to undertake a considerable amount of reworking of the data received and generated fresh data during the purchasing function.

Of the purchasing tasks included in the purchasing management function, only the assessment of the quantities of commodities to be purchased involved the use of measured data. The other tasks required the use of the particular knowledge of the availability and costs that form the skill of purchasing for the construction industry. Therefore, the information used for the purchasing function was defined as that information used to establish the quantities of commodities to be bought. The use of this information was examined under the headings of data received, not used, transformed/regenerated, generated and passed on.

6.10 DATA RECEIVED BY THE PURCHASER

Data received from the estimator.

- (i) contract documentation formerly the tender documentation, usually in one of the three forms described in the estimating function (Chapter 6.4).
- (ii) the estimate comprising
 - measured quantities (either client prepared or measured by the estimator);
 - labour costs and assessment of waste;
 - plant costs and assessment of standing time;
 - material costs and assessment of waste;
 - sub-contract and suppliers quotes;
 - preliminary costs; and
 - margin allowed.

The resource costs were often aggregated into unit costs, although most estimators observed did prepare a resource breakdown to a degree.

Data received from the planner:

(i) the programme for the works.

Data received from the surveyor:

(i) Notification of any decrease in profit margin or shortfall in targets.

6.11 DATA NOT USED BY THE PURCHASER

The purchaser dealt solely with the quantities of the commodities to be bought, therefore the following data received by him was not used:

- (a) labour resource costs;
- (b) plant resource costs;
- (c) preliminary items and costs referring to labour and plant;
- (d) preamble items referring to workmanship.

After the preparation of the material schedules, the measured data and estimators' resource breakdowns were no longer used. This meant that, with the exception of the sub-contract data, the measured data used by the purchasing management function was entirely reworked or freshly generated for the purchasing tasks.

6.12 DATA TRANSFORMED BY THE PURCHASER

Where the data received by the purchaser was not in a suitable format for use during the purchasing function, the purchaser was required to rework such data into a desirable format. Data transformed or regenerated in this way included:

measured quantities - the data received referred to the quantities of the finished construction works with no account taken of purchasing sizes. Although the estimator made an assessment of wastage, this was usually undertaken by means of a percentage addition and not accurate enough for the purchasing function. Therefore, the measured quantities were reworked or remeasured by the purchaser to take into account buying waste caused by the units of purchase, ie sheet sizes, minimum quantities, load sizes, etc. and usage waste, ie breakages, spillages, etc. on site.

- sub-contract quotes the purchaser may obtain alternative quotes in an attempt to reduce the costs allowed for by the estimator and consequently increase the profit margin.
- *material costs* the costs allowed by the estimator were transformed into target costs which the purchaser attempted to reduce by use of alternative merchants and suppliers and the negotiation of discounts.
- suppliers quotes again, the purchaser obtained alternative quotes if he felt he could reduce the cost and increase the company profit. The same tender data was used for obtaining alternative quotations, however.

6.13 DATA GENERATED BY THE PURCHASER

The purchaser assessed the total gross quantities of commodities required and ensured that they were on site at the appropriate time. In order to achieve this the purchaser generated the following data:

material schedules - these were found to comprise of descriptions of the material, the intended supplier and the gross quantity to be purchased. This latter was often cross referenced to its location in the construction works (vide Appendix C). Several types of schedules were generated for varying categories of material as follows:

- bulk items, eg aggregates, cement, sand, etc. used for long periods in large quantities throughout the construction period. These materials were relatively cheap and the wastage factor high;
- (ii) other large quantity items also used for long periods of time but which were not so cheap and required more careful supervision and control, eg bricks, concrete, etc.
- (iii) bulk and large quantity items were usually placed on "open order" with the supplier. That is, the quantity of the material required was ordered by the purchaser to be delivered to the site when called for by the site manager, either via the purchaser or directly from the supplier;
- (iv) standard items in smaller quantities, usually more expensive again and with longer delivery periods, eg doors, windows, etc;
- (v) one-off or special items requiring detailed ordering and careful handling on site as replacement not readily available; and
- (vi) items of any description where there was a long delivery period.

The purchaser placed the appropriate order with the supplier after the programme for the works had been compiled, unless the materials were on exceptionally long delivery periods. In which case an order might be placed as soon as the tender had been accepted by the client. Examples of data generated by the purchaser are contained in Appendix C.

6.14 DATA PASSED ON BY THE PURCHASER

To the planner:

- (i) materials for incorporation into the works with long delivery periods; and
- (ii) similarly sub-contractors.

To the site manager:

- (i) delivery dates for materials not on open order and quantities to be delivered;
- (ii) name, trade and means of contact for sub-contractors; and
- (iii) name of suppliers with whom open orders have been placed.

To the surveyor:

- (i) the target costs and quantities of materials ordered;
- (ii) the sub-contract quotes and contract documentation; and
- (iii) notification underestimated material costs.

C. THE PLANNING MANAGEMENT FUNCTION

6.15 DEFINITION OF THE PLANNING MANAGEMENT FUNCTION

The planning management function observed in the case studies was singular in purpose. This purpose was to compile a time based programme for the works within the specified contract period.

Two forms of programme were observed during the case studies. These were:

- (a) bar charts; and
- (b) critical path/network analysis.

A line of balance was used by companies A and C to monitor progress. Each type of programme represented the allocated time for the works in the construction sequence within a contractor defined construction period which may be less, but never more, than the contract period as defined in the contract. Costs (in the form of liquidated damages) for non-completion within the contract period without just cause (inclement weather, variations, etc. being just cause) may be heavy. Therefore, it was important for all the management functions to be aware of the planned programme and the progress of the construction works against that programme.

The planner was also observed to contribute to increasing the profit margin. This was achieved by skilful and accurate programming of the works in a shorter time than that anticipated by the estimator resulting in cost savings on the length of time plant, temporary accommodation, etc. was required on site.

The contract period may form part of the tender to be competed with against other contracting organisations. For example, when the project forms part of a development for sale or lease, the client may require a return on investment as quickly as possible. In such cases, the construction period may be more important to the client than the cost. Although no such contract was observed during the case studies, this was a point made by planners from company C (vide Appendix B). The planning management function can be defined, therefore, as the skeleton on which the post-contract management of a project hangs. The work undertaken by the planners enables the higher management to control the projects in hand, re-allocating resources from project to project as the need was indicated by the programme. The planning management function was responsible for collating the project progress data and updating and amending the programme in line with that progress, thereby assisting higher management control of the company work load.

6.16 EVALUATION OF PLANNING PROCEDURES

In order to compile the programme the planner was observed to undertake the following steps:

- (a) to break down the construction process described in the available information into time-based operations;
- (b) to liaise with the sub-contractors and incorporate their work schedules into the main programme;
- (c) to incorporate delivery dates for materials into the program; and
- (d) draw up the programme in a suitable format to illustrate progress accurately.

The planning management function continued throughout the contract period. The progress of the works was monitored and plotted onto the existing programme sheet/s usually weekly, representing the work completed to date.

The effect of any variations to the works, either client originated or due to a change in the assumed method of working, were evaluated and the programme adjusted to incorporate them. Variations which caused the new works to exceed the targeted times may involve a total re-programming of the project. In this case, an application for an extension of the specified contract period may need to be submitted to the client.

6.17 INFORMATION USED BY THE PLANNER

The information available for the planning function comprised of the general company data, the contract documentation and the data prepared by the other management functions. The planning management function required the representation of the entire construction process in time based operations or

sections. To this end any measured data contained in the available information was of little use unless received in a format which represented the construction sequence.

Therefore, the information used by the planner was defined as that information used to establish the time span for the complete construction process split into appropriate sections. This information also represented the contractors chosen method of working. The use of this information was examined under the headings of data received, not used transformed, generated and passed on to other management functions.

6.18 DATA RECEIVED BY THE PLANNER

Data received from the estimator:

- (i) contract documentation all as detailed for the purchaser;
- the estimate all as detailed for the purchaser, but not necessarily priced;

Data received from the purchaser:

- (i) details of materials on long delivery;
- (ii) material schedules showing the gross quantities to be purchased; and
- (iii) sub-contractors quotations and programmes if available.

Data received from the site manager.

Advice was sought from the site management regarding methods of working, particularly where the construction was unusual, complicated or had several obvious differing methods of execution. The information supplied by the site manager was usually received in a verbal form although notes were made by the planners.

6.19 DATA NOT USED BY THE PLANNER

The planner was observed to deal only with the time factor of the construction works and did not use the following data:

- (i) any data relating to the cost of the work; and
- (ii) measured quantity data not reflecting the construction sequence.

6.20 DATA TRANSFORMED BY THE PLANNER

Where data received by the planner was not presented in a format suitable for use without reworking, the data was transformed as follows:

material schedules - these were used to assess the time to be allowed for each section of the works. The time span was expressed as a manhours/days/weeks and the total quantities of the materials to be incorporated in each section provided a loose guide to the time required to undertake such incorporation; and

drawings - these were found to be the main source of information for the planning management function and were used in conjunction with the material schedules, the time spans were "taken off" the drawings in a similar manner to the measurement of quantities. The drawings were further used to provide locational information about the materials and construction works.

6.21 DATA GENERATED BY THE PLANNER

The planner co-ordinated the construction works in the first instance (this was undertaken on site by the site manager), ensuring that the work sequence was allocated sufficient time within the construction period. This works sequence was expressed in the form of a programme and as such formed the total of the data generated by the planner. Data expressed by this programme was found to be:

start and finish date:

- (i) for each element of the works;
- (ii) for the delivery of the materials; and
- (iii) for each sub-contractor.

Both the anticipated or planned dates were shown and, as the work progressed, the actual dates.

6.22 DATA PASSED ON BY THE PLANNER

The programme for the works was passed on to the site manager and the purchaser. The surveyor and higher management were not given a copy of the programme unless it was specifically requested.

68

Each time the anticipated programme for the works was revised, due to variations or delays, a copy of the revised programme was passed on to the management functions holding a copy of the original. Progress was not passed on by the planner; each management function was responsible for updating their own copy of the programme if they required to monitor the progress of the works (or alternatively visit the planning department and abstract the required progress data from the master programme). Progress was reported to higher management, however, usually at regular contract meetings with the other management personnel responsible for the project.

D. THE SURVEYING MANAGEMENT FUNCTION

6.23 DEFINITION OF THE SURVEYING MANAGEMENT FUNCTION

The surveying management function observed in the case studies was involved in the monitoring and control of the contract income and expenditure, particularly of the labour resource and sub-contracts. The surveyor may also be involved in the measurement of quantities for the preparation of the tender where none were measured by the client, but only one example of this was observed in the case studies and it was undertaken by a surveyor employed by company B.

The tasks undertaken by the surveyor to achieve the financial control of a contract fell into three categories:

- (a) preparing and submitting valuations of completed works and the final account for payment by the client;
- (b) targeting, valuing and authorising payments for labour and subcontractors, monitoring the expenditure on materials and plant; and
- (c) reconciling (a) with (b) to ensure that the contract was being managed at a profitable level.

An off-shoot of the surveyors management duties was monitoring (with the site manager) the construction works to ensure that they were being undertaken as detailed in the contract. The surveyor was responsible for ensuring that all works undertaken were ordered and paid for by the client in accordance with the form of contract applicable to the particular project.

The surveying management function was defined as a specialist, construction cost accountant who ensured that the project was profitable and undertaken in accordance with the form of contract. The surveyor was involved almost exclusively with the post-contract management of a project, although the estimator may consult the surveyor about the implications of unusual clauses in the tender documentation.

6.24 EVALUATION OF SURVEYING PROCEDURES

In order to achieve the aims outlined in 6.23 above, observations were made of the surveyor undertaking the following steps:

- (a) valuing the works for payment:
 - (i) abstract from the contract documents the tender price for each item of completed construction work;
 - (ii) assess the proportion of partially completed items of work and the value of same;
 - (iii) assess the quantity of unfixed goods and materials on-site and determine their cost plus delivery and margin;
 - (iv) assess the quantity of additional or omitted works and negotiate an appropriate value with the client's representative;
 - (v) abstract from the preliminaries the tender price for the items of completed preliminary works and assess the value of partially completed preliminary items.
- (b) targeting and valuing labour and sub-contract payments, monitoring material and plant expenditure:
 - (i) abstract from the contract documents the tender price for works undertaken by directly employed or labour only subcontractors and prepare target costs based on the construction sequence of the works and expressed in units suitable for the payment of this labour force. These targets were submitted to the site manager for use by him when negotiating payment rates, particularly with labour only subcontractors.
 - (ii) abstract from the contract documents the tender price for works undertaken by domestic and nominated subcontractors and set up sub-contract files for monitoring correspondence, progress, variations, valuations, etc.
 - (iii) abstract from the contract documents the tender price allowed for the various items of plant and prepare or provide the site manager with plant cost targets.
 - (iv) liaise with the purchasing department to ensure that the tender price for the purchase of materials was not exceeded and that problems with supply, variations to the works and wastage were accounted for and, where necessary, their

value reclaimed either against the contract or from insurance policies.

- (v) value the progress of the works and certify payments for directly employed labour and labour only sub-contractors in line with the targets previously prepared.
- (vi) value the progress of the sub-contract works and certify payments in line with the sub-contract documentation including negotiating payments for variations to the works.
- (vii) monitor actual works on-site to ensure that they were undertaken in accordance with the contract documents. Inform the client of additional works and variations which affected the contract period or had financial implications.

(c) reconcile (a) with (b) to monitor profitability:

- (i) prepare a monthly report reflecting income and expenditure for submission to higher management. This report reflected the expense that had been committed during the month even where payment had not been made, eg sub-contract payment terms usually allowed 28 days credit, therefore works completed by the sub-contractor may be paid for by the client prior to the release of monies by the main contractor. This also occurred with the supply of materials and plant.
- (ii) project the actual contract costs to anticipated total profitability forecasts for submission to higher management, highlighting areas where profitability was falling behind/increasing on original targets.
- (iii) provide cost comparisons for alternative construction methods for use by site and higher management.

The monitoring and reconciliation of expenditure and income continued throughout the contract period and on until the final account was settled.

6.25 INFORMATION USED BY THE SURVEYOR

It was observed that the surveying management function used two sets of information, each of which related to the same contract. One was for use when presenting information to the client when making the various payment claims throughout the contract and the other was prepared by the surveyor for use as an internal record of planned and actual expenditure. Use of this dual set of information resulted in a complex definition of data used, transformed, generated and passed on. Much of the data received was used in its original form and also transformed. Much data was also freshly generated. The examination of the use of data was documented as follows.

6.26 DATA RECEIVED BY THE SURVEYOR

Data received from the estimator:

- (i) contract documentation all as detailed for the purchaser;
- (ii) the estimate all as detailed for the purchaser.

Data received from the purchaser.

- (i) the target costs for the anticipated supply of the material resources based on the prepared material schedules;
- (ii) sub-contractors' quotations; and
- (iii) details of items which cannot be bought within the estimated price, ie exceeding targets and therefore potential loss making items..

Data received from the planner:

(i) the programme for the works.

6.27 DATA NOT USED BY THE SURVEYOR

The surveyor used all data referring to the quantities, costs and use of the contract resources and all the contract drawings on which this data was based, the data not used by the surveyor was all data referring to standards of workmanship and material quality.

6.28 DATA TRANSFORMED BY THE SURVEYOR

Data for presentation to the client - as stated above, data submitted to the client for payment claims was presented in the same format as the original contract documentation. Although reworking of this original data was not undertaken for the preparation of valuations/final accounts, an assessment of on site progress was made. This progress was found to be expressed in one of two ways:

(i) by percentage completion of the contract item of works; or

(ii) by actual/approximate measurement of finished quantities of work on site.

Payment for preliminary items was assessed in either of these two ways or:

- (iii) by a proportion based on the total value of completed works against the contract sum (excluding the value of the preliminaries);
- (iv) more commonly, assessed according to an evaluation of the actual expenditure incurred; or
- (v) a combination of two or more of (i) (iv).

Whilst the handling of this data for presentation to the client could not be said to involve much transformation other than assessing the proportions of completed works in the original measured format, the inclusion of variations to the contract (discounting increases/decreases in the quantities of the items contained in the original contract documentation) did involve the transformation of the actual use of the resources within the item of additional works into the measured format of the original measurement. The surveyors participating in this study found that submitting breakdowns of actual resource use, not presented in a measured unit recognised by the client, was unacceptable. The reason given for this was that cost comparisons of the contract rates and rates for the additional works were not possible if they were not presented in a similar format. Showing the labour hours was particularly frowned upon by clients as this led to the suspicion that daywork rates were being used without permission. Therefore, the actual resource usage data was transformed into quantities and unit rates suitable for presentation to the client.

Data use for sub-contract management - again, items of sub-contract work executed on site without variation could be used without substantial transformation. Only an assessment of actual progress was made, as described above. Where variations involved items of work not included in the original contract, the surveyor was involved in the transformation of sub-contract data.

Generally - In many cases, the format of the contract data was different to the format of the data collected from site regarding variations to the works, giving rise to an example of the dual sets of data used by the surveyor. These sets of data were: (a) *Priced quantities* - these were used without much transformation for the preparation of payment claims to the client, as described above. However, these quantities were also used by the surveyor for the internal monitoring procedures described in 6.24(b). This transformation involved the separation of the resources from the estimator's resource breakdowns into labour and plant sections. Both resources were then dealt with separately and the quantities and costs allowed by the estimator transformed into the labour and plant targets/schedules for use both by the surveyor and the site management (see data generated 6. 29).

- (b) Data from site comprising of the actual use of resources:
- (i) site data referring to contract variations were transformed into the original measured quantity data format for submission to the client. It was found that the data from site may detail work not in the contract and not constituting a variation (see 6.32(d) Method of Working) but resulting from a chosen method of working. This situation provides data that cannot be reconciled with the data provided by the client beyond a comparison of the sums of money.
- (ii) monthly financial statements were prepared from the reconciliation of the actual use of resources against the anticipated use contained in the targets.

(c) Drawings - these were used in conjunction with the priced measured quantities to provide locational information for the preparation of the target costs, valuations and final account and to cross-check the accuracy of the B/Q quantitites and descriptions.

6.29 DATA GENERATED BY THE SURVEYOR

The surveyor monitored the profitability of the contract and ensured that correct payments were made to sub-contractors and by the client. He also ensured that any additional works were incorporated into the contract and that adequate compensation was sought from the client for disruption and delay. In order to do this, the surveyor generated the following data:

target costs - the anticipated labour requirements were divided into trade gangs and documented in an assumed logical contract sequence of work stages. These divisions were then allocated target costs within those allowed by the estimator (directly employed and labour only sub-contractors only) - the plant targets comprised of schedules showing the type of plant, its function, the length of time allowed for on site and the target costs. An allowance for small items of plant was observed as a separate lump sum item for expenditure by the site manager as he saw fit.

Valuations - a summary of completed works to date for submission to the client for payment by him; and

- adjusted domestic sub-contractor accounts which included any remeasured data for payment by the main contractor.

Financial statements - produced monthly to monitor the actual and anticipated profitability of the contract where the contract data and the site data were aggregated and compared.

Contractual claims - produced for submission to the client usually on completion of the contract; and

- claims and contra charges against sub-contractors.

Final accounts - for the client;

- for domestic sub-contractors; and

Cost comparisons for site manager- the surveyor might be requested by the site manager to provide details of the cost implications of alternative methods of construction.

6.30 DATA PASSED ON BY THE SURVEYOR

To the site manager: -

- (i) the target costs for the labour and plant resources;
- (ii) cost comparisons of various methods of construction.

To the purchaser.-

(i) details of actual material and sub-contract costs and/or quantities that exceeded targets.

To higher management:-

(i) monthly financial statements highlighting successful and problem areas.

To the client:-

.

- (i) valuations in support of payment claims;
- (ii) final accounts;
- (iii) contractual claims; and

To domestic sub-contractors:-

- (i) payment certification including any remeasurement details or areas
- of dispute; and
- (ii) final accounts including any remeasurement details or areas of dispute.

E. THE SITE MANAGING MANAGEMENT FUNCTION

6.31 DEFINITION OF THE SITE MANAGER'S MANAGEMENT FUNCTION

The site manager's tasks revolved around the on-site construction works. These included the following:

- (a) allocation of all the resources to be used during the execution of the works, including negotiating payment rates with labour only subcontractors at the appropriate time and in the correct location;
- (b) the enforcement of the clients required standards of workmanship as detailed in the contract documentation;
- (c) the practical incorporation of variations into the works;
- (d) monitoring the progress of the works and reporting on such to the planner, surveyor and higher management;
- (e) taking the appropriate action if delays or difficulties occurred; and
- (f) deciding on the appropriate method of working to be utilised for the successful completion of the construction works within the period allowed.

The site management function was defined as the practical co-ordination of the works for whom the other management functions provided specific management information on which the site manager planned and executed the works to the greatest profitability. The function was often shared by two or more personnel, eg the site agent, plant manager, contracts manager being common titles under the site management function.

6.32 EVALUATION OF SITE MANAGEMENT PROCEDURES

In order to achieve the aims outlined in 6.31 above, site managers were observed to undertake the following steps.

(a) Allocate resources.

- materials these were ordered as detailed in the purchasing management function (vide supra 6.13), but open order items were requisitioned by the site manager as and when required, either via the purchaser or direct to the merchant or supplier.
- plant this was ordered direct from the hire company or in-house plant stock. If an item of plant was to be purchased specifically for the contract, the site manager liaised with higher management. The supply order was placed by either the purchaser or site manager. The plant used during the contract was not always the plant contained in the plant schedule compiled by the estimator or surveyor. The site manager made the ultimate decision on the type of plant required but the targets for expenditure on plant had to be met if the contract was to be profitable as it was unlikely that additional money could be allocated to the plant section after the tender had been finalised. Therefore, it was helpful to the post-contract management if the site manager advised on the type of plant required during the tender preparation.
- *labour* the allocation of this resource depended on the method of procurement.
- (i) directly employed: the workforce may be already employed or taken on for the contract. The allocation of the directly employed labour resource depended on the current and anticipated workload of the company, the location of the site and type of work undertaken, ie how many joiners, bricklayers, labourers, etc. were required to execute the works. The payment rates for the directly employed work force were found to be a matter of standard company policy but the site manager was required to negotiate bonus payments and (with advice from the surveyor) the desirability of overtime working.
- (ii) labour only sub-contractors: the site manager was responsible for procuring the required numbers and types of labour along with negotiating their payment rates within the targets set by the surveyor. These rates were not governed by any standard company policy and it was the responsibility of the site manager to obtain what he felt to be the best payment rate. In most cases this was found to be the cheapest, but where site managers had previous and

unsatisfactory experience with a particular labour gang, a higher rate may be paid for a different and more satisfactory one.

(b) Standards of workmanship - these were as detailed in the contract documentation. The site manager was responsible for ensuring that the site practices resulted in the performance of the contract in accordance with these required standards. Failure to do so may result in the condemnation and removal of work undertaken at the contractor's expense, thus placing the contractor in a potential loss making situation.

(c) Incorporation of variations - in most cases variations were incorporated without much disruption, however some variations required an alteration to the site manager's chosen method of working. In these cases, the site manager notified the surveyor who then prepared claims for extension of time, disruption, expense, etc. Variations could also affect the programme and the site manager kept the planner informed as to the type and extent of variation. The incorporation of variations affected the allocation of resources and this was undertaken again (as described in 6.32(a) above) as appropriate.

(d) *Monitoring the progress of the works* - this was required not only for the update of the programme but also to ensure the following:

- (i) the works were progressing within the time allocated;
- (ii) that further supplies of labour, plant and materials were allocated/requisitioned for arrival on site at the correct time; and
- (iii) to aid the programming of other projects being undertaken or tendered for by the company.

(c) Action for delays and disruption - if the planned progress was not achieved, the site manager took the following action:

- (i) notified the other management functions (including higher management) who then commenced their own duties relating to delays, disruption, etc;
- (ii) depending on the advice received from the other management functions, one or more of the following were undertaken:
 - additional labour taken on or overtime authorised;
 - alternative plant/material suppliers used, including (with permission from the client) the use of alternative materials;
- sub-contracts terminated and the contract placed elsewhere (not nominated sub-contracts); and/or
- determination of the main contract (in extreme cases only).

(f) *Method of working* - it was found that individual site managers each had favourite methods of expediting the works. The method of working was at the site manager's sole discretion. Simple examples of alternative methods of working were:

- the use of trench fill foundations in lieu of strip (School test project); and
- excavation across the site and backfilling in lieu of excavating foundation trenches (Industrial Units not a test project).

Care had to be exercised, however, if the client had specific requirements about methods of working. In both examples given the client's permission was required but the change was not treated as a variaton to the contract. The contractor was paid for work described in the B/Q not for work actually undertaken (see 6.28(b) Data from site).

6.33 INFORMATION USED BY THE SITE MANAGER

The site manager used information that detailed the works and aided the performance of his duties. The sources of this information were the contract documents and data prepared specifically for his use by the other management functions. The data prepared by other management functions was all, to varying extents, prepared to ensure efficient and profitable working conditions for the site. It was felt that the site, and consequently the site manager, was the fulcrum of the post contract management tasks undertaken within a contracting organisation.

6.34 DATA RECEIVED BY THE SITE MANAGER

Data received from the estimator:

 (i) contract documentation - all as described for the purchaser but not usually priced;

Data received from the purchaser:

- (i) suppliers with whom open and bulk orders placed;
- (ii) delivery dates for materials ordered by the purchaser; and
- (iii) details of domestic sub-contractors and proposed dates on site.

Data received from the planner:

(i) the programme for the works.

Data received from the surveyor:

- (i) targets costs for the labour force, detailed in units appropriate to the construction sequence;
- (ii) target costs for plant; and
- (iii) cost comparisons regarding alternative methods of construction.

6.35 DATA NOT USED BY THE SITE MANAGER

The site manager did not use any of the client prepared quantity data and was not usually given access to the tender prices for this data. It was found that little use was made of the client prepared descriptions of items of work, preference being given to the use of working drawings.

6.36 DATA TRANSFORMED BY THE SITE MANAGER

The site manager was not observed to transform or rework any data. The data he required for the performance of his duties was presented to him by the other management functions in a suitable format.

6.37 DATA GENERATED BY THE SITE MANAGER

The site was found to be a major source of fresh data regarding the actual use of resources and the progress of the works. This data was summarised as follows:

Actual use of resources:

- (i) materials advice notes and delivery tickets were submitted to the site manager (by the supplier or carrier) as materials were delivered to the site. These were followed by the invoices and account statements which were submitted direct to the purchaser or accounts department.
- (ii) plant again advice notes/hire tickets were submitted to the site manager by the supplier or hire company when items of plant were bought or put on/off hire. The purchase/hire was invoiced direct to the contractor's office.

(iii) labour - time sheets were completed for the directly employed labour force showing how many hours were spent working on site. Labour only sub-contractors productivity was recorded as completion or proportional completion of items of construction work. In both cases the format used for the presentation of this data was the same as that used in the surveyor's target costs.

Progress:

 the completed works were recorded against the programme to show the progress of the contract, usually be means of coloured bands or indicators against the proposed bands/indicators.

Variations:

 (i) a problem with a design may be anticipated by the site manager based on his construction knowledge and experience. In this case, a variation to the design was initiated by the site manager.

6.38 DATA PASSED ON BY THE SITE MANAGER

To the purchaser

- (i) requisitions for materials and small tools;
- (ii) notification of shortfall/surplus in materials supplied; and
- (iii) delivery tickets/advice notes for materials received.

To the planner:

(i) progress of the works against the original programme.

To the surveyor:

- (i) weekly labour returns;
- (ii) plant returns (if used);
- (iii) variations to the works; and
- (iv) notification of delays or difficulties experienced.

To higher management:

- (i) progress reports, usually monthly; and
- (ii) any additional information requested by higher management regarding delays and difficulties.

F. THE HIGHER MANAGEMENT FUNCTION

6.39 DEFINITION OF THE HIGHER MANAGEMENT FUNCTION

The role of higher management was found to involve the monitoring of contract progress and profitability based on the information provided by the supporting management functions. The overseeing nature of the higher managers function enabled problems to be anticipated and the managerial and technical experience available at this level could be drawn upon by the other management functions as required.

Higher management initiated the pressure upon the supporting management functions to perform the tasks allocated to them efficiently.

As such, higher management did not manipulate or generate data, any data required by the higher manager was provided by the supporting management functions already transformed into the required format. Higher management was found to be the general collection point for all the information generated within the company, including general accountancy and administrative information from sources outside the contract management functions. The conclusions drawn from all this data were used by the higher management to initiate company policy.

G. CONCLUSIONS

6.40 CONCLUSION

()

It can be seen from the preceding pages of Chapter Six that data used by the management functions can be grouped according to its usefulness, or otherwise to each individual management function. This grouping allowed the identification of which data was useful to all, which only useful to some and which not useful at all. The study also revealed which data had to be generated specifically by a management function group and whether that data was useful to others.

This study formed the basis for the plotting of data flow through the company and the identification of "data interfaces" described in Chapter Seven.

CHAPTER SEVEN: CONTENTS

DATA FLOW AND INTERFACES

7.1 Introduction

SECTION A : Data flow

- 7.2 Generally
- 7.3 Contract stages
- 7.4 Sequence of tasks
- 7.5 Pre-commencement stage
- 7.6 Construction stage

SECTION B : Data interfaces

- 7.7 Generally
- 7.8 Estimating Data Interfaces
- 7.9 Purchasing Management Function
- 7.10 Planning Management Function
- 7.11 Surveying Management Function
- 7.12 Site Management Function
- 7.13 Double Interfaces

SECTION C : Critical management tasks

- 7.14 Generally
- 7.15 Grouping of Management Tasks
- 7.16 Critical Data

SECTION D : CONCLUSIONS

7.17 Conclusion

CHAPTER SEVEN DATA FLOW AND INTERFACES

7.1 INTRODUCTION

This chapter takes the detailed data study described in Chapter Six and examines how the use of data is affected by the various stages of the contract and how data passes within and between the management functions.

The purpose of this particular portion of the study was to finalize the collection of information required upon which to commence the development of the measurement rules. The work achieved this objective by highlighting areas where existing data could not be used without alteration. These areas were called interfaces to show that the requirements of the data were different on either side of the interface and that the data could not pass through the interface (be used) without change.

The identification of the data flow and interfaces showed what was required of any proposed measured data if it was to streamline the data flow eliminating the interfaces and thus the need to rework or change data as it passed within and between the management functions throughout the construction sequence.

A. DATA FLOW

7.2 GENERALLY

It can be seen from the examination of the management function tasks and the use of data for the performance of these tasks, detailed in Chapter 6, that large quantities of data were passed within and between the management functions.

It was also observed that much of this data was re-worked by each function in order to perform their tasks. Large quantities of data were also freshly generated either for a specific task or for use by other management functions.

It was also concluded from the study of the management function tasks (vide supra Chapter 6) that there were two main sources of information:

- i) the contract documents; and
- ii) the site.

It was found that the contract documents contained information relating to the anticipated use of resources, including the estimators' projected resource breakdowns and method statements contained in the estimate/tender. Whereas the data initiated on site detailed actual historical use of resources and method of working.

7.3 CONTRACT STAGES

The use and type of data were found to vary depending on the point of progress through the contract stages. The contract stages were defined as:

- (a) **Pre-contract stage comprising:**
 - (i) receipt of invitation to tender;
 - (ii) acceptance/decline of invitation;
 - (iii) allocation of tender preparation to estimator;
 - (iv) preparation of the anticipated contact costs and associated resource breakdowns;
 - (v) tender adjudication in which overhead and profit margin added to estimators anticipated contract costs; and
 - (vi) submission of tender to client.
- (b) Post-contract pre-commencement comprising:
 - (i) contract agreement between client and contractor;
 - (ii) materials scheduled and orders placed as necessary;
 - (iii) programme for the works compiled;
 - (iv) labour and plant targets compiled;
 - (v) resources allocated;
 - (vi) method of working allocated; and
 - (vii) pre-commencement meeting of management functions including higher management, to finalise projected profitability, programme and method of working.
- (c) Post-contract construction stage comprising:
 - (i) setting up the site, eg compounds, huts, temporary works, etc; and
 - (ii) execution of the contract works including the incorporation of variations to the contract.

- (d) Post-contract final account stage comprising:
 - (i) removing all temporary accommodation;
 - (ii) final snagging; and
 - (iii) compilation, negotiation and agreement of the final account including any claims.

Of the above contract stages, it was observed that the following involved the use of measured data and were therefore studied in more detail:

- (a) **Pre-contract** (iv) and (v);
- (b) Post-contract (ii) (v) inclusive;
- (c) Construction (i) and (ii); and
- (d) Final account (iii).

It was also noted during the case studies that the method of working (b) (vi) had a distinct effect on the use of measured data, dictating the items measured and their grouping. Although the method of working did not in itself require the use of measured data, it was concluded that consideration must be given to the method of working when compiling a framework within which to define any measurement rules.

7.4 SEQUENCE OF TASKS

The sequence of the management function tasks using measured data was closely linked to the contract sequence detailed above. However, the integration of the management functions was split between the pre- and post-contract stages. It was found that the estimating management function was greatly involved during the pre-contract estimating stage, other management functions only became involved if specific advice was requested by the estimator. This situation was reversed during the postcontract stage where the estimator was only involved if specific advice was required by one of the other management functions. It was also noted that once the site works were completed and the final account stage entered, only the surveying management function was involved in the preparation of the final account unless assistance was specifically requested from other management functions.

Therefore the initial flow of measured data through a contract organisation was shown as



Fig 7.1

From Figure 7.1 it can be seen that the most complex integration of management functions occurred within the post-contract stages. The integration of the management functions at pre-contract and final account stages took the form of involvement only by specific request of the principal management function, ie estimator or surveyor.

Therefore, it was the post-contract stages that were examined in more detail and the flow of measured data within and between the management functions defined.

It was observed that the flow of measured data differed between the precommencement and the construction phases. The pre-commencement stage being principally a stage during which the contract documents and estimate were transformed and new measured data generated. The construction stage was found to involve the use of the data created during the precommencement stage and it was during this latter stage that the flow of measured data was most complex. Each stage was examined and the flow of measured data documented as follows:

7.5 PRE-COMMENCEMENT STAGE

The first step in the data flow was the receipt of the contract documents by all the supporting management functions and the estimator's data by the purchaser and surveyor.

Each of these management functions then undertook their allocated tasks as outlined in Chapter Six using the pre-contract data as the base source of information. However, whilst performing these tasks an amount of integration between the management functions was observed and a limited amount of data flow. A simplified version of this integration and data flow was illustrated in Figure 7.2.

The data flow was found to exist between tasks as well as between management functions. This data flow (simplified) was illustrated in Figure 7.3 showing that little data was used between tasks without some form of transformation, or abstraction or addition.

7.6 CONSTRUCTION STAGE

The data flow became more complex during the construction stage due to the creation of new data by the site. Therefore, the data exchanged during the pre-commencement stage was continually updated and amended to reflect the actual use of resources and progress during the construction works. The monitoring procedures undertaken during the construction stage by the planner, purchaser and surveyor were found to increase the amount of data transfer and the incorporation of variations to the contract resulted in a repetition of tasks undertaken during the pre-commencement stage.

It was observed that data was transferred between all the management functions participating in the construction stage. This flow was two way, each management function receiving data from and passing data to each of the other management functions. The type of data transferred depended on the tasks undertaken, therefore the simplified illustration of data flow shown in Figure 7.3 was broken down into tasks rather than the management functions and the type of transformation or abstraction of the data indicated.

CONTRACT STAGE DATA FLOW BETWEEN MANAGEMENT FUNCTIONS



91

92

ł

•

.

B. DATA INTERFACES

7.7 GENERALLY

It can be seen from Figures 7.2 and 7.3 that not only was there an integration and flow of data but that the data was amended as it passed between some of the tasks. The need for transformation showed that data being passed was not in a suitable format for use for the next task in the sequence. This resulted in a "barrier" or interface through which the data could not pass without time being spent altering the data into a suitable format. The interface was formed between two tasks each requiring the same data but in a different format.

The major interfaces observed occurred between the client prepared documentation describing the works and that required by the post-contract management functions for the performance of their duties. The one exception to this statement was the duties undertaken by the surveyor when preparing and presenting financial claims to the client based on the original contract documentation.

Once the client prepared data had been transformed into the required format by the management functions, the interfaces between tasks became less distinct. Data transformed by the management functions became more easily transferable between tasks, with the required data being abstracted directly from the source data.

The interface between the source data and the data produced was the result of re-working the source data. The data produced comprised of base units of data regarding the anticipated works which were then re-worked back into the tender format. Each set of data (source and produced) mismatched with the other and were not easily transferable across the interface.

7.8 THE DATA INTERFACES OBSERVED ARE LISTED AS FOLLOWS:

.

Estimating management function -



FIGURE 7.4 Estimating Management Function

7.9 PURCHASING MANAGEMENT FUNCTION -



FIGURE 7.5 Purchasing Management Function

The differences between the sub-contract quotes obtained by the estimator and the sub-contract placed by the purchaser did not involve the re-working of the source data and consequently did not exist within the definition of interface applied within this research.

7.10 THE PLANNING MANAGEMENT FUNCTION -



FIGURE 7.6 Planning Management Function

•

.

7.11 SURVEYING MANAGEMENT FUNCTION -



FIGURE 7.7 Surveying Management Function

7.12 SITE MANAGEMENT FUNCTION -

No interfaces exist for the site management function as the data used by the site manager for the execution of the works was presented in a suitable format either without transformation, eg the working drawings and specification, or already re-worked by the supporting management functions.

7.13 DOUBLE INTERFACES

The transformation of data from the tender documents by the estimator was observed to be a partial transformation only which, if the tender was successful, required further transformation to be of use to the post-contract management function. This gave rise to a complex situation where the source data, the tender document supplied by the client, passed through two transformations before it was of use for the post-contract management. This was termed a double interface and illustrated as follows:



FIGURE 7.8 Double Interface

The main cause of the double interface was the requirement of the estimators priced tender to be submitted in the same format as the clients tender documents. This had the effect of partial transformation of the source data (clients' tender documents) to allow the estimator to cost resource requirements but then the partially transformed data was re-arranged back into the format of the source data for presentation to the client.

C. DEFINITION OF THE CRITICAL MANAGEMENT TASKS

7.14 GENERALLY

In order to begin the definition of a set of measurement rules for builders' quantities it was necessary to establish which of the management functions had the most critical requirements for the measured data used during the execution of their duties. That is, which tasks were least flexible in the required format of measured data and therefore were the tasks that most needed to be satisfied by the measurement rules.

7.15 GROUPING OF MANAGEMENT TASKS

The management functions of estimating purchasing, planning, surveying and site management were all undertaking management duties directly related to the procurement and execution of contracts. It was found that not all the tasks performed by these management functions required the use of measured data, so these were discounted. Of the remaining tasks, it was found that, in some, the format in which the measured data was presented was not important; these tasks were also discounted. The tasks involving the generation and/or use of measured data in a rigid format were considered to be the critical tasks. The grouping of the management tasks into the three categories of (i) not using measured data, (ii) format not rigid and (iii) format critical, is detailed on Table 7.9.

It can be seen from Table 7.9 that there were six critical tasks which were performed by the planner, purchaser, surveyor and site manager. The evaluation of these management functions clearly indicated that, of these management functions, the surveyor manipulated and transformed the greatest quantity of measured data, followed closely by the purchaser. The planner and site manager were not observed to manipulate measured data. Therefore, the tasks of scheduling materials by the purchaser and targeting of labour and plant resources and financial control undertaken by the surveyor were deemed to be the critical tasks to which the greatest consideration need be given when defining a set of measurement rules.

MANAGEMENT FUNCTION	TASKS NOT USING MEASURED DATA	TASKS WHERE FORMAT NOT IMPORTANT	TASKS WHERE Format is Critical
Estimator	 i) Pricing preliminary items, provisional & PC sums ii) Assessing profit & overheads margin 	i) Tender preparation - data varies between contracts already	None
Purchaser	None	None	i) Scheduling materials for ordering
Planner	i) Programme	None	i) Assessing time-spans for programming
Surveyor	None	i) Valuations & final account for client. Client documents varied format already	 i) Targeting labour & plant resources for the site. ii) Financial control
Site Manager	i) Standard of work- manship & materials		i) Quantities of materials delivered
	ii) Execution of construction works		ii) Labour & plant targets



7.16 CRITICAL DATA

In order to commence the drafting of a set of measurement rules for builders' quantities, the measured data required for the performance of these three critical tasks was defined. It was observed that the measured data used was, in all cases, broken down into the separate resources of labour, materials and plant and that this data split also occurred within the tasks performed by the other management functions. This split in the use of measured data continued throughout the post-contract stage. The only tasks observed which involved the use of the aggregated resource data were those which were undertaken in order to present data to the client, ie valuations and the final account. As these latter two tasks had no interface with internally prepared measured data, with the exception of the incorporation of variations to the contract, these tasks were excluded from the framework within which the measurement rules were defined.

The measured data required for the performance of the critical tasks listed on Table 7.9 was defined. It was observed that the measured data used was, in all cases, broken down into the separate resources of labour, materials and plant and that the data relating to these resources were used by different management functions. This split in the use of measured data continued throughout the post-contract stage and the only observed tasks involving the use of the aggregated resource data were those which were undertaken in order to present data to the client, ie valuations and the final account. As these latter two tasks had no interface with internally prepared measured data, with the exception of the incorporation of variations to the contract, these tasks did not form a consideration to the drafted measurement rules.

D. CONCLUSIONS

7.17 CONCLUSION

It can be seen from Figure 7.3 that the flow of data through a construction company could be streamlined by reducing the number of interfaces. This would reduce the amount of reworking and transformation of data as it was passed between the management personnel.

The flow chart at Figure 7.10 shows the improved flow of data using Builders' Quantities in the format recommended in Chapter Nine. It can be seen that the double interface identified in Table 7.8 was removed with only a single transformation of data between the clients' tender documents and the contractors' estimate in the format of Builders' Quantities. The transfer of the Builders' Quantities from the contractors' estimator to other management personnel was undertaken without further reworking of data. The post-contract management personnel were only required to confirm the measured quantity data and use the costs set by the estimator to establish cost targets for the procurement of the resources. The required cost and quantity data can therefore be taken straight from the estimate without reworking. The research had now reached a stage where specific quantity data requirements could be examined (vide infra Chapter Eight) as the study to this point had identified where the various difficulties with the transfer and use of data lay. Chapter Seven showed which of the management tasks had critical data requirements and what data was, firstly, available and secondly, required. All these were aggregated to show that the best use of Builders' Quantities would occur if they were incorporated in the pre-contract stage (vide Figure 7.10).



FIG. 7.10

NOTES

ABBREVIATIONS:

EST. - ESTIMATOR S.MAN - SITE MANAGER P.MAN/PLANT MAN - PLANT MANAGER BUYER - PURCHASER

1 SUB-CONTRACT MEANS DOMESTIC SUB-CONTRACTOR

2 LABOUR TARGETS FOR DIRECTLY EMPLOYED LABOUR & LABOUR ONLY SUB-CONTRACTORS

3 PLANT MAY BE OWNED, HIRED OR BOUGHT IN AS REGUIRED

4 BOLD LINES & BOXES SHOWN WHERE DATA INTERFACES HAVE BEEN REMOVED BY USING BUILDERS QUANTITIES

CHAPTER EIGHT : CONTENTS

CONSIDERATIONS AND PRINCIPLES FOR THE MEASUREMENT RULES

8.1 Introduction

SECTION A : Measured data for critical tasks

- 8.2 The Purchaser
- 8.3 The Planner
- 8.4 The Surveyor
- 8.5 The Site manager

SECTION B : Role of the domestic sub-contractor

- 8.6 Generally
- 8.7 Relationship with the Management Functions

SECTION C : Format for presentation

- 8.8 Generally
- 8.9 Preliminaries
- 8.10 Construction works

SECTION D : Considerations covering the Method of Measurement

- 8.11 Generally
- 8.12 Resource split
- 8.13 Buying unit

SECTION E : Principles of measurement for Builders' Quantities

- 8.14 General constraints
- 8.15 General measurement principles
- 8.16 Excavation and groundworks
- 8.17 Labour resource
- 8.18 Material resource
- 8.19 Plant resource

SECTION F : Development of standard take-off sheet

- 8.20 Generally
- 8.21 Initial Taking-Off Sheet Format
- 8.22 First draft of Single Taking-Off Sheet
- 8.23 First Revision of Single Taking-Off Sheet
- 8.24 Final Taking-Off Sheet Design

SECTION G : Development of the measurement rules

8.25 Generally

SECTION H : Conclusions

8.26 Conclusion

CHAPTER EIGHT

CONSIDERATIONS AND PRINCIPLES FOR THE MEASUREMENT RULES

8.1 INTRODUCTION

The framework within which to define Builders' Quantities was detailed as:

- A consideration of measured data for the critical management tasks;
- B the incorporation of domestic sub-contracts into the post-contract management functions;
- C the format for the presentation of the measured quantity data that best suited the critical tasks.

The information collected during the case studies detailed in Chapter Six and Seven were considered under these three headings. This study gave rise to the considerations and principles governing the method of measurement detailed in Sections D and E of this chapter. This study, in turn, enabled the first draft of the measurement rules to be compiled along with a pro-forma taking-off sheet. It was at this stage that the second grant was awarded by SERC and the method adopted for the development of the measurement rules changed from reliance on the case studies to field trials. During the field trials the work undertaken by the researcher was critically appraised by the participating contractors' management personnel.

In order to define a set of measurement rules for builders' quantities, the measured data requirements of the critical management tasks were defined. This measured data became the base elements for the builders' quantities.

The term measured data referred to quantities of labour, plant and materials that formed the construction works, including temporary and preliminary works. The measured data also comprised of some form of written description of the resource items that the quantities referred to. Each postcontract management function used measured data in different ways and required the measured data to provide specific information in order to perform the tasks undertaken.

These specific requirements were outlined below:

A. DEFINITION OF MEASURED DATA FOR THE CRITICAL TASKS

8.2 THE PURCHASER

The purchaser required measured data which provided two specific items of information:

- (a) the total quantities of each material to be bought; and
- (b) the buying unit of each material.

(a) Total quantities.

The purchaser placed orders for material supply in various ways, each method involved the use of measured data as follows:

- (i) open orders for bulk quantity items, eg sand, aggregate, cement. The purchaser notified a supplier that a site had opened and that these bulk quantity items were required. The quantities of individual deliveries of these materials were usually assessed by the site manager and ordered directly by him from the supplier;
- (ii) large quantity orders, eg common bricks, ready mixed concrete, again called for direct from the supplier by the site but a specific total quantity had been previously assessed and notified to the supplier by the purchaser;
- standard items, eg doors, windows, quantities assessed and delivery arranged by the purchaser; and
- (iv) one-off or special items, eg special bricks, made to measure joinery fittings, again quantity assessed and delivery arranged by the purchaser.

(b) Buying units

The buying unit was the unit of quantity used by the supplier and manufacturer when selling their product, ie the unit of quantity the product was bought in. The purchaser required measured data to express the quantities of materials in these units, this information was then given to the supplier or manufacturer and the material purchased.

Examples of commonly used buying units included:

Bricks	-	per thousand or fired batch;
	•	per number for small quantities or specials;
Blocks	-	per hundred, ten or multiples thereof;
Ready mixed		
concrete	-	per cubic metre in standard loads, part loads
may		be surcharged;
Reinforcemen	nt:	
Fabric	-	per sheet, standard size & gauge;
Bar	-	per bar, standard length & diameter, large
		quantity per tonne;
Aggregates	-	per tonne; and
Drainage:		
Pipes	-	per 3/6m length, standard diameter;
Fittings	-	per number, standard diameter.

Buying units for timber included:

Carcassing -	per standard length and section;	
Joinery trims -	per standard profile, length & section;	
Sheet boarding-	per standard sheet size & thickness; and	
Fittings -	per standard unit.	

Non-standard items were available but required machining and making up to order, which could result in a delivery period of several weeks.

8.3 THE PLANNER

The planner required measured data which expressed two items of information:

- (a) an indication of the construction method; and
- (b) measured data showing the broad dimensions and quantities for each element of construction.
- (a) Construction method

The site manager advised the planner on the alternative methods of construction and the proposed methods if required. The sequence of constructing a single building broadly followed the stages of:

- (i) excavate and lay foundations;
- (ii) construct water-tight shell; and
- (iii) construct internal accommodation.

Although there was little practical variation from these stages, the type of construction dictated the method of achieving each stage. The planner was required to anticipate the effect construction methods will have on the construction time, which in commercial interests was kept to a minimum.

(b) Measured data

Measured data was not used to prepare the programme other than providing a guide to time span. The measured data used by the planner informed him of the overall dimensions and total quantities of materials within elements of construction to enable the assessment of the time required to complete each element. Some examples of this type of measured data included:

- (i) the length & depth of foundations trenches;
- (ii) plan size of ground floor slabs;
- (iii) storey height and girth of external walls;
- (iv) number and area of floors;
- (v) length and depth of drain trenches; and
- (vi) areas of external pavings.

8.4 THE SURVEYOR

The surveyor used measured data for preparing the cost targets for the labour/plant resources and for undertaking the financial control of the contract. The targets were prepared for use by the site manager and as such were presented in a format suitable for use by the site. The financial control was recorded by means of measured data either for presentation to the client for interim valuations/final accounts or as a basis for internal financial statements for use by higher management.

Therefore the surveyor required measured data which provided the following information:

- (a) the quantities relating to each element of the construction;
- (b) the labour content of the above; and
- (c) the plant content, usually total requirement but may be expressed per item of work or elementally.

(a) Construction sequence

The surveyor used measured data in the construction sequence for all the internal targeting and monitoring tasks. Measured data presented in a construction sequence format aided the preparation of interim valuations which reflected actual progress on site. The construction sequence was outlined as follows:

Traditional brick buildings:

- prepare site including reduce levels;
- excavate and lay foundations;
- sub-structure brickwork;
- ground floor slabs;
- superstructure brickwork (constructed in lifts);
- forming openings in external walls;
- first & subsequent floors (separately);
- **ro**of;
- staircases;
- finishing trades (usually sub-contract);
- services (ditto);

-	drain runs between manholes;) may run
) concurrently
-	manholes;) with sub and
) super-
-	external pavings;) structure
) works
-	outbuildings etc; and)
-	fencing (usually sub-contract)).

Where there are several structures, each were documented separately. Standard building types were measured singly and multiplied in a summary.

Framed buildings:

- prepare site as above;
- drive piles (if required);
- excavate for and lay foundations, ground beams, pile caps, stanchion bases etc;
- steelwork in lifts (usually sub-contract);
- concrete beams/columns etc (in lifts);
- floor slabs each storey;
- infill panels/cladding (may be sub-contract);
- roof;
- staircases; and
- finishing trades and external works as above.

Where data was presented within elements of construction as listed above, the surveyor was able to assess the value of completed works for interim claims more accurately.

(b) Labour content

The surveyor provided the site with labour targets. These targets showed the amount of money available to the site manager for the purchase of manpower for each item of construction. These labour targets reflected every item of work that an operative carried out and was paid for. Three methods of employing and therefore paying a workforce were observed:

- (i) per item of work (labour only-sub-contract) commonly termed "lump labour" or "on a price";
- (ii) per week plus possible bonus (directly employed); and
- (iii) per hour (day labour).

Per Item of Works

Putting labour force on a price was observed to be the more common method of employing. This method was usually used for the procurement of labour only sub-contractors although it was observed to apply to directly employed labour on one refurbishment contract during the case studies. In order to prepare labour targets for the site manager, the surveyor was required to provide a maximum labour cost for each item of work within the elements of construction (see examples above). This cost reflected actual payments made to the labour force and was therefore net of any margin. National Insurance payments were not normally made for labour only sub-contractors and income tax was dealt with by the accounts department depending on the individual contractors tax status, ie 715 or SC60 certification.

The surveyor, therefore, required very specific information in order to prepare these targets. This information related to the amounts of money allowed by the estimator and the unit of bargaining used by the site in order to procure the labour force. These units were titled "buying units" for the purpose of identification and were dealt with in the same way as the buying units used by the purchaser for the purposes of developing a set of measurement rules.

Certain directly employed skilled labour was also paid by this method. This was observed to apply in particular to bricklayers where a price would be negotiated per metre lift of completed work. This method of payment was used as a form of bonusing, the greater the quantity of work completed the higher the weekly payment was.

Weekly Pay

Weekly pay was observed to be the method of paying directly employed labour (with the exceptions given above). Each of the site personnel were expected to work a basic 40 hr week for a standard weekly wage. This wage was usually negotiated before the individual operative was employed and followed national guidelines. The wages were also found to be influenced by market conditions, eg if a trade was in short supply a higher payment rate may be used and vice versa. The surveyor was required to provide the site with a target that reflected the maximum number of hours to be spent on each item of work again within the elements of construction. These targets were then used by the site manager to ensure that the works were undertaken within the financial limits set during the estimating stage. It was also found that these targets were used for the assessment of productivity bonuses, eg when an item of work was completed within the time allowed an additional payment was made to the labour force as a productivity reward. Again, the target cost for directly employed labour reflected the actual payment to be made, before tax and National Insurance contributions were deducted by the accounts/wages department. It was found, however, that the labour rates used by the estimators were compound rates that included on-costs such as holiday contributions, employers NI liability, training levies, etc. Therefore, the surveyor not only had to break down the estimators data into the construction sequence but also split out the basic labour rate. The buying units for weekly paid labour were therefore defined as the basic hourly labour payment rate appropriate to the skill of the operative which were used to allocate the target hours/cost for each item of work.

<u>Day labour</u>

Day labour rates were very rarely used without the permission of the client. However, it could be argued that payment by hourly output forms the basis of (ii) above but the term day labour is used here to mean payment for items of work the extent of which are unknown and for which, therefore, no finite allowance had been made in the estimate. Items of day labour cannot be targeted for and therefore the use of day labour was excluded from definition of the measurement rules.

(c) Plant Content

Plant used during the construction works was either contractor owned, hired or purchased for the contract (sometimes sold on completion). A schedule of plant requirements was drawn up sometimes by the estimator at pre-contract tender stage, but more usually in the post-contract pre-commencement stage. The plant schedule detailed the type of plant, the anticipated length of time it was required for and an allocated budget cost. This was passed on to the site manager who then allocated the plant resources within the budget costs. The plant actually used on site was not necessarily that detailed in the plant schedule but the budget costs did not vary.

8.5 THE SITE MANAGER

The measured data used by the site manager referred to the allocation of the labour resource and allowed the type and amount of labour to be easily abstracted. This enabled the site manager to obtain the appropriate labour force within the target cost at the correct construction stage. The site manager also recorded the progress of the works in the units of measurement used for the target costings.

Plant resources were allocated in line with the plant schedule prepared by the surveyor/estimator although alternative methods of procurement or types of plant were utilised depending upon the site managers chosen method of working and/or availability of suitable plant.

The site manager also used measured data referring to the material resource. He needed to know what quantities of materials were being delivered and when. The site manager made his own assessment of the day to day requirements for the bulk and open ordered materials, but this assessment was not based on a scientific measurement process. The initial quantities of materials required were obtained from the purchaser or from the clients measured data and deliveries arranged in line with actual and anticipated progress.

The site manager referred to the contract documentation for the workmanship specification but did not use any specific quantity data from the contract documentation for the management and supervision of the construction works.
B. THE ROLE OF THE DOMESTIC SUB-CONTRACTOR

8.6 **GENERALLY**

Much of the site works were found to be undertaken by domestic subcontractors. These sub-contractors were responsible for supplying all the labour, materials and plant required for the performance of the sub-contract works. The sub-contract works were portions of the main contract that the main contractor either did not have the resources or the experience to undertake. This work was tendered in much the same way as the main contract, the main contractor became the "client".

<u>NOTE</u>: These sub-contractors were not nominated by the client under the main contract. The tender documentation used comprised of portions of the main contract tender documentation prepared by the client. It was found to be very rare that the main contractor actually prepared any tender documentation for these sub-contracts other than a standard form of tender and/or conditions of contract. The estimators and purchasers interviewed during the case studies maintained that they had never personally undertaken such tasks, although some suggested that this might be undertaken for a design and construct form of tender where the main contractor was responsible for preparing all the design documentation.

It was found, therefore, that the situation facing main contractors when using client prepared measured data for the post-contract management of a contract, applied equally to the domestic sub-contractors. Namely the reworking and regeneration of the measured data into a format suitable for use by the domestic sub-contractors' post-contract management functions. However, this research was confined to the use of measure data by the management functions of main contracting organizations only.

8.7 RELATIONSHIP WITH THE MANAGEMENT FUNCTIONS

These main contracting management personnel all dealt with measured data referring to domestic sub-contracts and these sub-contracts had the following effect on their use of measured data.

<u>The Estimator</u>: the sub-contract trade was tendered as a single resource for the works as described in the main contract tender documentation. Measured quantities of the various items of work were deemed to be outside the scope of this research as like trades tendered on the same measured data. The estimator obtained a total price for the works irrespective of the quantities, eg the plastering works cost $\pounds X$ total, the number of square metres was unimportant to the estimator who only required a competitive price for the sub-contract works. Where measured data was not prepared by the client the domestic sub-contract tender documentation comprised only of drawings and a specification. Measured data was still not important to the estimator as the domestic sub-contractor was deemed to have included for all the works required of him.

<u>The Purchaser</u>: like the estimator, the purchaser regarded the domestic subcontract trades as a single commodity to be "bought" for a single cost. The purchaser re-tendered the sub-contract trades if he felt a more favourable quotation could be obtained from alternative sub-contractors. The purchaser then placed an order with the sub-contractor to carry out the works.

<u>The Planner</u>: the planner needed to allow time in the program for the subcontract works to be undertaken and for the integration of the various other sub-contractors and directly employed labour. This was either done with assistance from the relevant sub-contractors or the planner made his own assessment of the time required based on the main contract period and previous experience. The planner referred to measured data to gain an idea of the scope of the sub-contract works to be incorporated into the main contractors' programme.

<u>The Surveyor</u>: the surveyor also dealt with sub-contractors as a single commodity. However, the surveyor was required to make monthly valuations of the sub-contract works and interim payments to the subcontractors. A major problem arose where substantial variations in the subcontract works occurred and re-measurement was required. Works tendered on traditional BQs provided the surveyor with a schedule of rates on which to base this re-measurement. Specification and drawing contracts required more work to complete the valuation of such variations. Variations should not occur to any great extent with design/construct contracts where design work was undertaken in-house, however if variations arose and no traditional BQ existed, the problem was similar to that encountered with spec and drawing contracts. <u>The Site Manager</u>: was required to co-ordinate the sub-contractors on site. To achieve this he needed to know the scope of the sub-contract works and the time allocated for their completion within the programme. The site manager did not use any measured data relating to domestic sub-contracts.

Therefore, the trades sub-contracted by the main contractor did not involve the use of significant amounts of measured data. The trades found to be most usually sub-let were excluded from the considerations for the definition of a set of measurement rules for this reason. After the exclusion of these trades, the trades remaining were the ones usually undertaken by the main contractors directly employed or labour only sub-contractors and upon which the measurement rules were based. These trades were found to be:

- (i) excavation and ground works;
- (ii) concrete work;
- (iii) brick/blockwork;
- (iv) woodwork;
- (v) drainage;
- (vi) any of the above in external works; and
- (vii) alterations (excluding specialist demolition).

C. FORMAT FOR PRESENTATION

8.8 GENERALLY

The construction works comprised of two distinct portions:

- (i) site set up and temporary works which enable the contractor to execute the contract (all removed on completion); and
- (ii) the permanent construction works required by the client.

Both portions had costs allocated to them and were therefore measured.

8.9 PRELIMINARIES

Setting up the site and undertaking temporary works formed part of the preliminaries to the contract and as such did not have quantities allocated to them by the client. An examination of the method of measuring these preliminary items adopted by contracting organisations showed that where the contractor was not influenced by a client originated method of measurement the resources required to undertake the site set up and temporary works were all measured separately in their buying units. The measurement of items by use of buying units was consequently adopted as the basis for the measurement of builders' quantities defined by this research, as this method was already used and considered acceptable by contractors' management personnel.

8.10 CONSTRUCTION WORKS

An examination of the type and format of the measured data required by the post-contract management functions was undertaken and is described in the preceding chapters. The first step in defining a set of measurement rules based on these requirements was the definition of a suitable format for the presentation of the measured data relating to the construction work.

It was found that the construction works fell into three sections:

- (a) sub-structure and earthworks;
- (b) super-structure works; and
- (c) external works.

This division was formed naturally by the operational sequence of the site works. The sub-structure and earthworks were always undertaken first with the super-structure and external works undertaken, often concurrently, but after the sub-structure and earthworks. The process of design was found to fall into the same three sections often being undertaken by more than one design office, eg Architect, Structural Engineer, Landscape Designer.

Data measured within each of these three sections should therefore be presented separately. An overlap between these sections may occur during the purchasing management function if the purchaser is required to order filling material and timber supports for the sub-structure and external works sections or where there are similar concrete mixes, reinforcement and/or formwork in the sub- and super-structures. Some overlap may also occur with brick/blockwork in this instance. However, this overlap is confined to the use of measured data by the purchaser only, all the other management functions use measured data within the operational sequence of the three sections listed.

Alteration works may be measured as complete operations (spot items) in an optional fourth section or may be split between the three main sections given above. The division depends on the method of working adopted and the way these items are undertaken on site. For example, a substantially new build project with only a small amount of alteration works may be grouped differently from a project vice versa.

Each main section is divided into sub-sections, each of which contains various elements of construction work. These sub-divisions and elements all follow the construction sequence. All construction works fall into one of the following elements within the appropriate sub-division:

Sub-structure and earthworks:

- (i) excavation and ground works:
 - site preparation including removing existing structures and topsoil (to be preserved);
 - bulk excavation; and
 - filling to make up levels

- (ii) sub-structure:
 - foundations including ground beams, pile caps, stanchion bases, strip and trench fill footings;
 - floor slabs including raft foundations and thickenings;
 - walls below DPC including basements; and
 - any other works below DPC level

Super-structure:

- (i) structural shell:
 - loadbearing walls and/or frame including openings;
 - floor structure;
 - roof structure; and
 - steps and staircases
- (ii) non-structural components:
 - non-loadbearing walls/partitions including openings;
 - sheet and board flooring; and
 - ceilings (not sub-contracted)
- (iii) fixtures and trims:
 - joinery fittings and trims (insitu finishes sub-contracted)

External works

- (i) drainage:
 - between manholes; and
 - manholes
- (ii) pavings:
 - excavation (may be included with site preparation);
 - sub-bases; and
 - concrete/brick pavings including kerbs, hardcore, reinforcement etc; and
- (iii) landscaping:
 - earthmoving where not undertaken during site preparation works;
 - filling ditto; and
 - seeding and planting where not sub- contracted
- (iv) external structures: each type measure separately, if deemed necessary, as detailed in sub-/super-structure sections.

Alterations (optional section):

.

- (i) forming/blocking up openings including replacing and/or repairing existing doors/windows etc;
- (ii) inserting and/or removing walls and partitions including repairing/repointing exist;
- (iii) replacing and/or repairing floors;
- (iv) replacing and/or repairing staircases and steps including forming new openings in floor structure;
- (v) replacing/repairing joinery trims and fittings;
- (vi) Work externally:
 - replacing/repairing drainage;
 - replacing/repairing pavings; and
 - landscaping as above.

D. CONSIDERATIONS GOVERNING THE METHOD OF MEASUREMENT

8.11 GENERALLY

The measured data is drawn up initially by the estimator, or QS on his behalf, but consideration has been given to the requirements of the postcontract management functions. These post-contract management functions have been identified and the critical tasks requiring the use of measured data in a specific format defined.

8.12 RESOURCE SPLIT

It was observed that the use of measured data by these post-contract management functions was split into that regarding labour and/or plant, and that regarding materials. It was further observed that this split occurred throughout the post-contract management functions and is illustrated as follows:

Purchaser	-	uses data relating to material resources;		
Planner	•	mostly data relating to labour and plant but some		
		consideration given to the quantities of materials;		
Surveyor	mostly data relating to labour and plant but may also			
	monitor actual material expenditure against target costs;			
		and		
Site Manager	•	almost entirely confined to use of data relating to labour		
		and plant, only ensures adequate quantities of materials		
		are available to ensure progress.		

Therefore, the material and labour/plant split is an important consideration when measuring data for use during the post-contract management of a project. An examination of the existing estimating task revealed that the resources were already being considered separately with allowances for waste being incorporated prior to aggregating the total resource costs into a unit rate for items of work measured by the client. Eliminating the final aggregation would reduce the amount of work undertaken by the estimator when preparing the tender.

8.13 **BUYING UNIT**

A second important consideration governing the measurement of builders' quantities is the unit of resource purchase termed "buying unit" in this research. As it is advocated that the material and labour/plant resources are measured separately an appropriate buying unit may be used for each, as opposed to the current situation where all resources are aggregated under a measurement of the material resource only.

Materials - the examination of the purchasing management function showed that materials were ordered and supplied in standard buying units. The estimator also used these buying units and the cost per buying unit to price the material content of the project regardless of the unit of measurement in the tender. By measuring the material resource within an operational element of construction the wastage factor may be more accurately assessed within the confines of the difficulty/ease of that construction. The assessment of material waste within an element of construction will provide the purchaser with measured data that can be easily abstracted thus eliminating the need to remeasure material quantities (although it was asserted by the purchasers interviewed that they would still check a certain amount of the estimators measurement). The surveyor/purchaser will be able to monitor the actual use of the materials against the estimators anticipated quantities as each element of construction is undertaken because the estimate reflects the quantities of materials in their buying units within the operational sequence of the works.

<u>Labour</u> - as stated previously, the buying units for the labour resource vary according to the method of employing or "buying" these resources. This buying is usually undertaken by the site manager who negotiates with the labour force within the targets/budgets prepared by the surveyor from the estimate The preparation of these targets are complex and involve not only the contractors' method of working, but also the aggregation of items of work into negotiable elements of construction from which the weekly output can be monitored and the workforce paid. These buying units are initially based on labour time but may be built up into lump sum costs for compound elements of construction.

<u>Plant</u> - this is the simplest of the three resources with only three main buying units as discussed previously. The allocation of the plant resource is

essentially time based as are the three buying units. Larger items of plant may be allocated directly to a particular item of work, however it was found that certain items of plant, eg dumper trucks, were used for a great variety of tasks and were often on site for the majority of the contract period.

E. PRINCIPLES OF MEASUREMENT FOR BUILDERS' QUANTITIES

8.14 GENERAL CONSTRAINTS

After consideration of the results of the case studies and interviews with contracting management personnel, the following principles were drawn up. It was maintained by these management personnel that if the measurement rules were to be successful they should fulfil the following criteria:

Each building type should be documented separately to assist the tasks of programming, allocating resources, valuations and cost control.

The building design and the site conditions must govern the method of measurement adopted. Differing structures may be grouped, described and/or quantified in the manner felt to most appropriately reflect the proposed method of working. The grouping of measured data must be flexible enough to allow the easy incorporation of the actual method of working (if different) at a later date.

Measurement of the elements of construction works is to be undertaken within the format detailed above.

The measured unit depends upon the buying unit or method of procurement for the resources measured.

Measurement of an item within an element of construction is defined by the allocation of the labour resource (except excavation - see below). The plant (if appropriate) and material resources are detailed separately but within the same measured item. Therefore each measured item becomes a miniature "Bill of Quantities" containing details of all the resources required to undertake the item of work measured. This is the reverse of the current situation where the unit of measurement is governed by the net quantity of material resource and no further measured detail is given.

The labour resource is measured within its buying unit which can be said to be the "trade" employed. These trades were found to be:

Plant & operator	-	excavate;
Labourer	•	fill; concrete; drainage and simple
		formwork, reinforcement, demolitions &
		alterations;
Bricklayer	•	brick/blockwork including alterations and
		building in doors etc; and
Carpenter/Joiner	•	woodwork and board finished including
		alterations; formwork.

Each operative may be either directly employed or labour only sub-contract (labour/plant sub-contract for excavation). Again this is the reverse of the current situation where the traditional trade definition depends upon the type of material being fixed rather than on the type of operative or gang allocated to undertake the works.

8.15 GENERAL MEASUREMENT PRINCIPLES

<u>Lifts and drops</u>: construction works proceed in vertical stages commencing at ground level (upwards and downwards). Therefore the measurement of the construction works also follows the vertical plane, either in drops (deep excavation), lifts (walls) or storeys (frames, floors etc).

<u>Work piece item</u>: measurement of construction work is undertaken within the elements detailed in Section D above. An element comprises of various work piece items each of which are measured separately. A work piece item is defined as all work undertaken by the same labour gang (or type of labour gang) between breaks in the construction sequence for works undertaken by different labour gangs. The description of the work piece item must define the extent of work included in the measurement. A work piece item may be a compound item detailing the fixing of several differing materials providing it fulfils the criteria defining a work piece item.

<u>Take-off sheets</u>: measurement of the work piece items should be undertaken on a take-off sheet that allows the resources to be detailed completely separately but under a single work piece item description. Therefore, all resources should ideally be documented on the same sheet or cross referenced if this is not possible. Large work piece items may require several pages of measurement and these should be fixed together and/or numbered or referenced so that they can be identified as measured data for a common work piece item. Adjustment to work piece items may be listed separately in an adjustment section either within each element or as a stand alone adjustment "bill". In both cases, all adjustments must be crossreferenced to the work piece item in which they occur. Vide Chapter 8, Section F: Development of the taking-off sheet.

8.16 EXCAVATION AND GROUNDWORKS

The measurement of excavation and groundworks differs from the method of measuring all other construction works because the allocation of the resources is reliant on plant outputs.

<u>Note</u>: Excavation by hand is measured in accordance with the principles of measurement for labour outlined below.

There are two types of excavation, (a) scraping operations and (b) digging or bulk excavation operations.

<u>Scraping operations</u>: measured per square metre area to be stripped because the method of removal involves passing backwards and forwards over the site until the required level is reached. The average depth or cubic quantity to be moved must be assessed however to allow a calculation of time based on the anticipated plant output.

<u>Bulk excavation</u>: measured in cubic metres because plant outputs are assessed per cubic metre. The quantity is the net quantity before bulking as the spoil does not bulk until removed from its location. Adjustments to the excavation process can be measured as additions to allow for location and difficulty, eg deep excavation or obstructions. These adjustments are time based and detailed separately. The bulk excavation item is based purely on the quantity of spoil removed. For example some adjustments may be detailed as:

Bulk excavation = 10,000 cubic metres (total excavation)

Adjustments:

Basement - add standing time for shuttering = 2.00m deep = 1.50 hrs 4.00m deep = <u>1.75 hrs</u> 3.25 hrs

- add time for removing plant on completion of basement excavation = <u>2.50 hrs</u>

Stanchion bases - add allowance for bucket change = 300mm bucket = 2 No x 0.20 hrs = 0.40 hrs 500mm bucket = 5 No x 0.20 hrs = <u>1.00 hrs</u> <u>1.40 hrs</u>

The gross quantity of material excavated ie including bulking, must be measured for disposal. The unit of measurement is per tonne. An outline calculation of the number of lorry loads (usually 5-6 tonnes) may be advantageous as part loads may be surcharged. Adjustments may be made to this gross calculation to reflect standing time whilst loading/unloading and to allow for tipping charges.

Where the same sub-contractor is excavating and disposing of the spoil or both operations are to be undertaken in-house, the unit of measurement is per tonne. Actual progress can then be monitored from the tipping tickets which detail the weight of spoil disposed of. The use of bulking or weight conversion factors will convert the cubic quantity into tonnes. A single item of excavate and dispose can be measured with adjustments detailed separately as required.

8.17 LABOUR RESOURCE

The method of measuring the labour resource depends on the buying unit of the resource. This may be a straightforward time based buying unit or an aggregated buying rate used by the site when negotiating for the procurement of labour only sub-contractors. The unit quantity reflects the number of buying units required to undertake the element of construction measured. The unit quantity is an aggregated quantity which may comprise of several measured items. These measured items may be measured in more than one unit and detail the labour resources required to undertake the element of construction works. The effect of location and difficulty/ease of construction can be incorporated into the measurement.

For example external load-bearing cavity walls comprise several materials but only one labour resource. Each wall is measured individually per building type, ie wall A, wall B, gable 1 etc. The wall dimension is its average (centre line) length between corners and this length may be given in the description, eg:

Wall A; 6.5m long		
Buying unit (commonly)	=	per metre lift;
Unit rate	=	compound, labour rate for
		brick & blockwork, cavity,
		ties etc;
Unit quantity	=	height in metres

Therefore, wall A; 6.5m long x 10m high is measured as: 10m x £cost per 6.5sm (cost per metre lift measured overall openings).

Adjustments may be for the incorporation of openings, labours, the effect of location etc as additions/omissions stating the lift in which they occur. These adjustments are not incorporated into the wall measurement but detailed separately and cross-referenced.

8.18 MATERIAL RESOURCE

Materials are measured in their buying units. The quantities measured must include for buying and usage waste and also any compaction.

Measurement in the first instance is by linear, square or cubic metres (or item if applicable) of the finished length, area or volume of the material incorporated into the building. The net measurement can then be converted into the appropriate buying unit, eg half brick wall comprising 100sm net, would be converted as follows:

100sm x 60 No/sm = 600 No bricks + usage waste = gross total.

Because the format of measurement follows the operational and locational sequence, adjustments to this gross total quantity for cutting, breaking while lifting etc are added as they are anticipated to occur.

Allowances must be made for sundry materials eg plugs, screws, spacers, tying wire etc. It is not usually possible to allocate an exact quantity to these items but their costs can amount to a noticeable sum when the merchants invoices are submitted. These sundry items are usually bought in a minimum quantity and often held in stock at the main contractors yard. Because the quantities handled are large, the wastage factor is similarly large.

The measurement of the material resource is undertaken with the measurement of the labour resource and, although detailed separately, this measurement falls short of compiling full material schedules. A form of take-off sheet providing sections for detailing the labour/plant and material resources separately should be used.

8.19 PLANT RESOURCE

Plant may be measured in one of two ways:

<u>Plant schedules</u>: detailing the types of plant, source, ie hire, contractor owned etc, and length of time on site. Schedules are used for the following items of plant:

- (i) major items : buying unit may include operator;
- (ii) plant used for a variety of construction works eg mixers, compressors;
- (iii) plant used for transporting around site, eg dumper trucks, conveyors etc; or

<u>Allocated to a specific item of construction works</u> detailed within the measured data for the element of construction in which it occurs, eg compactors, drills, breakers etc.

Plant may be measured by either of these two methods and both methods may be used within the same tender/contract.

Where items of plant require lifting within the construction, eg scaffolding, the labour required for assembly and removal should be detailed with the appropriate construction lift.

The buying unit for plant depends on the method of procurement as follows: <u>hired plant</u> - bought per day, week or negotiated long term agreement.

<u>contractor owned plant</u> - may be costed as an overhead to the company or allocated a usage charge for its anticipated working life when initially purchased. This usage charge reflects the minimum amount to be recovered each day/week in order to cover the purchase price, depreciation and interest on the capital loan/investment.

<u>plant bought specifically for the contract and sold or scrapped on completion</u> of the works - the amount to be recovered is a lump sum based on the difference between the purchase price and the anticipated selling/scrap value plus interest on the capital loan/investment.

F. DEVELOPMENT OF STANDARD TAKING-OFF SHEET

8.20 GENERALLY

In order to assist the taking-off process, the contractors management personnel interviewed thought a standard taking-off sheet should be developed. This sheet should be designed in such a way as to aid the taking-off process and allow easy abstraction of data by the management personnel after the initial measurement.

The taking-off sheet must allow all the resources to be measured in accordance with the principles outlined in Section F of this chapter. The development of a standard taking-off sheet took place over a period of eighteen months and involved four revisions of format. These revisions ran concurrently with the revisions of the measurement rules themselves and reflected the changes required by the management personnel during the testing and field trial period.

8.21 INITIAL TAKING-OFF SHEET FORMAT

The first stage in the development of the measurement rules identified the need to measure the site resources separately. It seemed logical, therefore, to devise a series of taking-off sheets that enabled this. A system of scheduling the resources was developed, each resource having a standard taking-off sheet that reflected its particular needs. The system was based largely on the material resource as was current measurement practice. The sheets design had their roots in the material schedules prepared by the purchasers.

The scheduling system and associated measurement rules are contained in the research work files. The comments and criticisms of the contractors' management personnel are contained in Appendix D - Walkerdine.

The scheduling system was found unanimously unsuitable by the management personnel participating at the time, for the following reasons:

- estimators were reluctant to use several different sheets whilst measuring an item of construction work as this involved considerable

additional work and increased the measurement/estimating time to an unacceptable level;

- the system was capable of relating the separate resources to their location within the construction;
- the system placed too great an emphasis on the materials resource which was already a criticism of existing methods of measurement; and
- it was found that the system was difficult to relate to the contractors method of working and did not allow the measurement sequence to reflect the construction sequence, again a criticism of existing management processes.

For these reasons, a system based on separate scheduling of resources was abandoned in favour of a taking-off sheet that allowed all resources to be measured on a single sheet.

8.22 FIRST DRAFT OF SINGLE TAKING-OFF SHEET

The problems posed by the design of a single sheet of paper that allowed all the resources to be measured together, but individually, were primarily ones of layout and space. The sheet designed is illustrated in Figure 8.1.

This taking-off sheet was tested on a proposed factory extension tender based on a specification and drawings using the first draft of the measurement rules. The results of this test are contained in Appendix E.

Whilst the overall concept of the taking-off sheet met with approval from all the management personnel several criticisms were made:

- the estimators felt that difficulties were still arising with the measurement of the individual resources, lack of space allocated to the actual measurements made it difficult to relate the quantities to each other. It was felt that this would encourage measurement errors;
- the purchasers echoed the above comments, adding that they could not easily establish where the material quantities had come from and would be reluctant therefore to trust their accuracy;
- the surveyors felt that the sheet did not allow easy abstraction of labour rates for targeting the labour resource for use by the site management.

CONTRACT REF :

BUILDING	No/Type
----------	---------

.

SUB-STRUCTURE / SUPER-STRUCTURE / EXTERNAL WORKS /ALTERATIONS

OPERATIONAL WORK GROUP :-eg site strip, shell, second fix, drainage etc.

OPERATION DESCRIPTION :-

labour i plant į 1 margin 1 total MATERIALS. i IGross Oti Rate i 1Net Qntyl Waste ! ! Total Operation Cost carried forward

FIGURE 8.1

They also suggested that it was unnecessary to total the labour, plant and margin and that monitoring profitability would be easier if the margin was given separately.

These comments were taken into account and the taking-off sheet revised.

8.23 FIRST REVISION OF SINGLE TAKING-OFF SHEET

The first revision made was to include dimension columns for the material resource. Space was also made to allow the labour and plant rate and the quantity of each to be shown, thus aiding abstraction of this data at a later date. This taking-off sheet is illustrated in Figure 8.2.

This revision was tested on the MIRA building (see MIRA first draft, held in work files). During the testing, the costing columns were revised again and the MIRA building substantially remeasured. This third sheet (shown in Figure 8.3) was also used for the United Reform Church project where a complete resource management system was used for the first time. This project is contained in the work files.

Comments received regarding the sheets used were more encouraging with the management personnel agreeing that a combination of the two sheets used allowing a full breakdown of the material net, waste and gross quantities with the additional column for the margin for each resource would be a more workable system. However, it was generally felt that there was still room for improvement with the underlying criticism still being one of lack of space.

8.24 FINAL TAKING-OFF SHEET DESIGN

Whilst the format was now substantially agreed in content, layout needed to be improved. This was achieved by turning the sheet sideways so that the data ran from side to side rather than up and down. Although in itself a minor operation, this successfully overcame the problems caused by lack of space and gave the added bonus of making the measured data easier to read and follow, allowing continuation of measured items onto following sheets. This taking-off sheet is illustrated in Figure 8.4 and was used for the remaining tests of the office block project and the alterations to the supermarket.

In its final printed form, it would be recommended that the taking-off sheets be produced in NCR pads giving an original and three copies, one each for the surveyor, purchaser and planner. The site manager would receive data in the form of targets from the surveyor and purchaser and would not therefore require an individual copy.

BUILDING TYPE/REF :	CONTRACT REF :	
CONSTRUCTION SECTION : .	OPERATIONAL ELEMENT :	<u> </u>
LOCATION PEF :		

WORK PIZCE DESCRIPTION :

3317	OF HEASUREMEN	17 :			•			
-		1	· · · ·		1	1	1 .3131	
1		· ·			Duantity	Aace	l Labour	Plant
					1	1		1
					1	1	1	1
i	1				1	i	1	
i	i				1	ł	1	i
t		1			4	1		}
-	1				1	1	1	
1	1	1			4	1	1	1
					1		1	1
		I			1	1	1	i
1					1		1	1
i	1				1	i	1	1
					4	ł	ł	
ļ		1			1	1	1	
		1			1	1	1	ł
	1	1			1	1	1	
					1	1		
					1		1	
	1	1			1	1	1	1
i	i	l			1	ł	1	ł
1	•	ļ.			1	1	ļ	ł
1	•	\$			4	1	1	1
1	ł	· ·			1	1	I	ł
·	. ł	1			1	1	1	f
f	·].					1	1	
		•			1	1	1	1
1	1	1			1	1	I	
						Į –		
1			•		1	1		
					1	1	1	
					1	1	1	
f					1	•	1	
1					1	1	1	
1					1	1	1	•
1	1							
1		1						
1								
1		4						
		1			L			
1			•	to Pa	ao :		i l	
4		1 .			- ,			
		MATERIALS		1 1/40			-	
		1		Quantity	Waste	Quantity	Race	Total
1		1			}			
1	ł	ł		1			‡	
	1	1		1	{ i			
	1			1	f.			
	1							
ł	}							
	1	1.		t l				
	1.	1]			1	
	I			i				
	1			į . I	·		ļ	
1	1	ł		! !				
1	1	ł		} I			· •	
	1			1			1	
Į]	1		1 1				
ł				; !			I	
1	1	1	•				1	
	ł			I [1	
		1				i i	1	
		i i	I	l j	. 1	: 1		
1	1	4	1	نسا	1	ł		
						-	f	

:

:

:

2

FIGURE 8.2

CONTRACT REF :

BUILDING No/Type	CONSTRUCTION SECTION :
OPERATIONAL ELEMENT :	LOCATION REFERENCE :
·	

ITEM DESCRIPTION :





FIGURE 8.3



FIGURE 8.4

G. DEVELOPMENT OF THE MEASUREMENT RULES

8.25 GENERALLY

The measurement rules underwent a similar development and revision process to the taking-off sheet. This development took place concurrently and the comments from the management personnel applied to both documents in many cases. As the documentation of this development is lengthy, the individual drafts of the measurement rules have been detailed separately in Appendix C along with the comments and criticisms received from the various management personnel in Appendix E.

H. CONCLUSIONS

8.26 CONCLUSION

Chapter Eight set down the considerations and principles for the development of the measurement rules for Builders' Quantities, based on the findings of the case studies detailed in Chapters Six and Seven and in Appendix B, the interviews with experts in Appendix D and the field trials documented in Appendix E.

CHAPTER NINE : CONTENTS

MEASUREMENT RULES FOR BUILDERS' QUANTITIES

9.1 Introduction
9.2 Sub-structure
9.3 Super-structure
9.4 External works
9.5 Alterations

CHAPTER NINE

MEASUREMENT RULES FOR BUILDERS' QUANTITIES

9.1 INTRODUCTION

The following measurement rules are presented in tabular format for ease of reference and to maintain consistency with existing standard methods of measurement published by the RICS and ICE.

The rules are based on the conclusions drawn from the research undertaken within contracting organisations, testing on a variety of projects and the comments and criticisms of contracting personnel.

The measurement sections follow the operational sequence of:

- 1. Sub-structure A. Excavation & groundworks:
 - I. Site preparation
 - (a) Demolition
 - (b) Remove vegetation
 - (c) Remove topsoil
 - (d) Cut and fill
 - II. Bulk excavation
 - (a) Excavation
 - III. Back filling
 - (a) Backfilling excavations
 - Sub-structure B Sub-structure:
 - I. Foundations
 - (a) Foundations (excluding rafts)
 - II. Rafts and Beds
 - (a) Rafts and beds
 - III. Frames and Walls
 - (a) Concrete frames
 - (b) Masonry walls
 - (c) Concrete walls

- 2.
- Super-structure A. Structural shell:
- I. Loadbearing walls/frame
 - (a) Concrete frames
 - (b) Masonry walls
 - (c) Concrete walls
- II. Suspended floors and roofs
 - (a) Timber floors and roofs
 - (b) Concrete floors and roofs
- III. Steps and staircases
 - (a) Timber or metal
 - (b) Concrete

Super-structure B. Non-structural components:

- Non-loadbearing walls
 - (a) Masonry walls
 - (b) Timber partitions
- II. Joinery

Ι

- (a) First fix
- (b) Second fix
- (c) Fixtures and fitting
- 3. External works A. Drainage:
 - I. Pipe runs
 - (a) Excavation and ground works
 - (b) Pipes

II. Manholes

- (a) Excavation and ground works
- (b) Foundations
- (c) Walls
- (d) Suspended slabs and covers

External works B. Pavings:

- I. Excavation
 - (a) Site preparation
 - (b) Bulk excavation
 - (c) Backfilling
- II. Sub-bases
 - (a) Beds and sub-bases
- III. Pavings
 - (a) Insitu pavings
 - (b) Precast paving
 - (c) Kerbs and edgings

External works C. Landscaping:

- I. Earthmoving
- II. Imported filling
- III. Seeding & planting

External works D. External structures:

Notes for guidance

4. Alterations generally

Alterations A. Openings in existing walls (inc.fitting doors etc):

- I. Forming
 - (a) Forming openings
- II. Blocking up
 - (a) Blocking up openings

III. Altering existing

(a) Altering existing openings

Alterations B. Walls & partitions (inc bonding to existing & joinery fittings/trims):

- [•]I. Inserting new (a) Insert new wall
- II. Removing existing
 - (a) Remove existing wall
- III. Altering existing
 - (a) Alter existing wall

IV. Repairing inc repointing

(a) Repair existing wall

Alterations C. Floors:

- I. Remove & renew existing
 - (a) Remove and renew existing floor
- II. Repair existing
 - (a) Repair existing floor
- III. New finish inc preparation
 - (a) New finish including preparation

Alterations D. Staircases:

- I. Insert new inc forming new opening/well (a) Insert new
- II. Remove & renew existing
 - (a) Remove and renew
- III. Remove existing & close well

(a) Remove and close well

- IV. Repair/alter existing
 - (a) Repair/alter existing

Alterations E. Joinery items:

- I. New fittings/trims
 - (a) New fittings
- II. Remove fittings/trims
 - (a) Remove fittings
- III. Repair/alter existing fittings/trims
 - (a) Repair/alter fittings

Alterations F. Work externally:

- I. Trace & repair/renew existing drainage
 - (a) Repair/renew drains
- II. Excavate & new drainage
 - (a) New drainage
- III. Remove/renew existing paving
 - (a) Remove/renew existing paving
- V. Repair/alter existing paving
 - (a) Repair/alter existing paving
- VI. Landscaping
 - (a) Landscaping

The following rules form the final draft set and are the fourth revision.

9.2 SUB-STRUCTURE

SECTION 1 : SUB-STRUCTURE

SUB-SECTION A : Excavation & Groundworks ELEMENT I : Site Preparation

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In Nr	 i) Demolish existing (described) structure; approximate overall size stated; including stacking in spoil heaps (temp or permanent) stating total bulked quantity to be moved. (large scale demolition specialist sub-contract) 	per structure (identified) hours per operative; stating type, eg labourer; tradesman etc. Extra Over: for carefully removing material for salvage; materials itemised separately Extra Over: for separating, stacking and burning combustible material on-site;	per structure (identified) total price for demolition work complete including: - salvaging described materials; - separating, stacking & burning all waste, combustible materials;
In Tonne	ii) Dispose off-site rubble & rubbish from demolitions; Nr & size of loads stated; giving total bulked quantity of spoil;	hours to load; per load hours to dispose; per load lorry & driver Tipping charges per tonne	labour/plant sub- contract price per load (quoted) including tipping charges;

WORK GROUP a) : Demolition

NOTES:

- 1) Where demolition, stacking and/or disposal by machine, hours per item of machinery (defined) measured as given above for directly employed labour. Plant included in sub-contract cost.
- 2) Disposal off-site by lorry given per load to allow ease of costing and monitoring from tip tickets.
- 3) Tipping charges to be given as separate item under directly employed labour, as they are a service required rather than a contractor's resource.

SECTION 1 : SUB-STRUCTURE

SUB-SECTION A : Excavation & Groundworks ELEMENT 1 : Site preparation

·		· ···· ·		
Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant	
	i) Clear scrub and saplings; state approx. area (per m ²) per defined location and	hours for machine to pass over site per pass required	total cost to strip per defined area of vegetation including stacking in spoil	
	approx. depth of scrape; stacking in spoil heaps for disposal;	Extra Over: for stacking in spoil heaps; per defined area;	heaps and burning as necessary.	
In m ²		Extra Over: for separating combustible material on-site; either per area or whole site.		
	ii) Cut down trees and grub up roots; each tree or tree group identified; stacking for disposal	hours per tree or tree group; Extra Over: for separating defined trees for salvage/sale;	cost per tree or tree group including sorting and stacking for disposal or salvage (trees for salvage to be identified)	
		Extra Over: for stacking for disposal off site;		
In Nr		Extra Over: for separating and burning on site, combustible material;		
	iii) Dispose vegetation off site; total bulked quantity assessed; per	hours per load to load;	labour and plant cost to load and dispose including	
	lorry load (load size stated);	hours to dispose; per load lorry and driver;	tipping charges;	
In Load		tipping charge per load;		

WORK GROUP b) : Remove vegetation

Contd/....

.

SECTION 1 : SUB-STRUCTURE

SUB-SECTION A : Excavation & Groundworks ELEMENT 1 : Site preparation

WORK GROUP b) : Remove vegetation (Cont'd)

NOTES:

- 1. Use of machinery as demolition above.
- 2. Definition of scrub and saplings is any vegetation that can be removed with excavating machinery.
- 3. Definition of tree is growth that requires separate cutting equipment or
- 4. Definition of tree group is where trees grow sufficiently closely to be measured as a single work piece, ie cutting can move from one to the other without a break in working procedure.

SECTION 1 : SUB-STRUCTURE

SUB-SECTION A : Excavation & Groundworks ELEMENT 1 : Site preparation

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
	i) Strip topsoil; per defined area (eg whole site) stating approx. depth and net m ³ ;	hours per defined area; stating plant type and output;	cost for sub- contract labour and plant to strip topsoil per defined area;.
In m ²		Extra Over: for moving plant between areas;	
In m ³ bulk	ii) Store topsoil on site per defined area; per m ³ total bulked quantity; approximate distance to spoil heap stated;	hours per defined area to transport and stack spoil; Extra Over: for banksman if required; hours	cost to transport and stack topsoil in permanent or specified spoil heaps; other handling included in disposal off site;
In Load	iii) Dispose of topsoil off site; per defined area; per defined load size; stating total bulked quantity;	hours to load per load; hours to dispose; per load; lorry and driver; Extra Over: for loading direct from excavation including standing time; excavator and lorry; Tipping charge or credit from sale;	cost to dispose total bulked quantity per load; including tipping or delivery charges or credit from sale;

WORK GROUP c : Remove Topsoil (to be preserved)

NOTES:

- 1. Topsoil used on site for external works is measured in the appropriate section.
- 2. Topsoil is only measured separately when it is to be preserved for re-use or sale. Tipping charges would not normally be applicable but topsoil not re-used on site may incur transportation/delivery costs to alternative location.
SUB-SECTION A : Excavation & Groundworks ELEMENT 1 : Site preparation

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In m ³ net	i) Levelling over site stating type of plant and output; identify each area of cut and each area of fill; per m ³ net quantity of earth to be moved; stating maximum depth of cut and maximum depth of fill;	hours for cutting & transporting to fill area stating plant type and output; hours for levelling and compacting fill; stating plant type and output; Extra Over: for banksmen as required;	cost for levelling site per total net quantity of earth moved.
In load	ii) Dispose of surplus spoil off site; per defined load size; total bulked quantity;	hours to load & dispose as topsoil 1.A.I.c)ii) and iii) above.	as topsoil 1.A.I.c)ii) and iii) above.
In Load	iii) Imported fill to make up levels over site; state material type; method of compaction and maximum depth of fill; location identified;	hours to transport; spread and compact; stating plant type and output; total bulked quantity to be handled m ³ ;	cost for transport; spread and compact fill; total bulked quantity to be handled m ³ .

WORK GROUP d) : Cut & Fill Over Site

NOTES:

- 1. The decision to measure as cut and fill is based on the assumed plant type and scale of the earthmoving operations.
- 2. A site with poor bearing soil that requires large scale stripping and filling with imported material may be classified in this category. Likewise, where cut only is required. In both cases, the cost of filling with excavated spoil detailed in i) above is omitted and the excavated spoil disposed.
- 3. The disposal item must include for suitable excavating plant for loading prior to disposal.
- 4. Directly employed banksmen may be required for labour only subcontractors.
- 5. Labour output for imported fill is checked from delivery tickets.

SUB-SECTION A : Excavation & Groundworks ELEMENT II : Bulk Excavations

	· · · · · · · · · · · · · · · · · · ·		
Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In	i) Bulk excavation; per m3 stating total net quantity; including working space and/or removal of spoil for	hours for excavator and operatives; per plant type stating output;	cost for total excavation per m ³ ;
m ³ net In m	battering sides of excavations;	Extra Over: for excavating trenches per m; each compartment separately;	Additional cost for: trenches; per metre; state average m ³ per metre run; each compartment separately;
In Nr		Extra Over: for excavating in Nr; small compartments; stating approximate dimensions;	Additional cost for: small compartments; in Nr; state approximate dimensions and m ³ each;
In drop		Extra Over: for deep excavation; each compartment separately; per defined drop depth; stating approximate m ³ per drop;	Additional cost for: deep excavation; each compartment separately in m ³ ; stating maximum depth;
In m ³ net		Extra Over: for additional time required for breaking out defined material type (like types grouped together); per m ³ per compartment:	Additional cost for: breaking out defined material type; per m ³ ; per compartment;

WORK GROUP a) : Excavating

NOTES: (hand excavation measured as for machine above)

- 1. Extra over items are to include for moving plant between drops and/or compartments, bucket changes, depth, difficulty and the like.
- 2. See clarification notes (Chapter 10.5, A.II A)i)) for definitions of excavation types.
- 3. Directly employed banksman may be required for sub-contract excavator.

SUB-SECTION A : Excavation & Groundworks ELEMENT II : Bulk Excavations

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In m ³ net	i) Cont'd	Extra Over: for additional time required for other specified operation; per m ³ ; per compartment	Additional cost for: other specified operation per m ³ ; per compartment;
In Load	ii) Dispose of spoil off- site; per defined load size; total bulked quantity;	hours to load and dispose as topsoil 1.A.I.c)ii) and iii) above.	as topsoil 1.A.I.c)ii) and iii) above.
	 iii) Earthwork support; each compartment separately as: Trenches: In Nr state length of trench; 	hour for labour to collect, make up and fix support; state first or subsequent use;	cost to collect, make up and fix support; state first or subsequent use;
	Small compartments: In Nr;	hours to strike and set aside;	cost to strike and set aside;
In Nr	Deep excavation: per excavation face; per drop;	hours for disposal; method stated, eg return to store; burn, etc.	cost for disposal; method stated;

WORK GROUP a) : Excavating (cont'd)

NOTES:

1. In each case the average depth of the support must be stated. Where the difference between the minimum and maximum depths is deemed sufficient to invalidate the use of an average labour rate, earthwork support may be measured in appropriate drops.

SUB-SECTION A : Excavation & Groundworks ELEMENT III : Back Filling

Unit of	Work Piece Item	Directly Employed	Sub-contract
Measurement		Labour and/or Plant	Labour and/or Plant
In m In Nr	 i) Backfilling excavations including working space; state material type (type defined by resources required); per defined foundation compartment; stating m3 bulked quantity, as follows: Trenches: per m of trench; Small compartments: In Nr; 	hours to transport, place and compact; stating plant requirements and outputs; 	cost to backfill including plant and excavating from temporary spoil heaps;

WORK GROUP a) : Backfilling Excavations

NOTES:

1. Where excavated material is used for backfilling, an adjustment must be made to any disposal quantity previously measured as appropriate.

.

SUB-SECTION B : Excavation & Groundworks ELEMENT I : Foundations

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
	i) Preparation of excavated surfaces; per defined foundation compartment as follows:	hours to level/ compact excavated surface; state plant type and output;	cost to level/ compact;
In Nr	Trenches : per m Bases: In Nr	hours to transport; place and compact blinding bed; including any mixing;	cost to transport; place and compact blinding bed; including any mixing;
	ii) Preparing pile caps per defined pile;	hours to cut and prepare as necessary; assumed method stated;	cost to prepare; assumed method stated;
	 iii) Reinforcement; per defined foundation as follows: Trenches : per m Bases: In Nr 	hours to transport and place reinforcement including cutting, bending, tying, spacing as required; state bars or mesh;	cost to lay reinforcement all as direct labour;
In Nr		Extra Over: for reinforcement in kickers;	Additional cost for reinforcement in kickers;
	iv) Edge formwork; per defined foundation; stating average depth; including kickers; as follows:	measured as earthwork support, see 1.A.II.a)ii);	as earthwork support, see 1.A.II.a)ii);
In m	In trenches: per m of trench	hours for placing formwork to face not at the edge of the foundation, eg	cost for placing formwork not at edge of foundation;
In Nr	In bases: per base;	step, internal face of wall kicker, etc.	

WORK GROUP a) : Foundations (excluding rafts)

SUB-SECTION B : Excavation & Groundworks ELEMENT I : Foundations

WORK GROUP a) : Foundations (excluding rafts) (Cont'd)

Unit of	Work Piece Item	Directly Employed	Sub-contract
Measurement		Labour and/or Plant	Labour and/or Plant
In m In Nr	 v) Concrete: per defined foundation; as follows: In trenches : per m of trench In bases: per base; 	hours to transport, place and compact concrete; state reinforced/plain; Extra Over: for inserting (described) void formers Extra Over: for casting in bolts, fixings and the like;	cost to transport, place and compact concrete; state reinforced/plain; Additional cost to insert (described) void formers Additional cost for casting in bolts, etc.

.

SUB-SECTION B : Excavation & Groundworks ELEMENT II : Rafts & Beds

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In Nr	 i) Preparation of excavated surfaces; per defined compartment; stating approximate area m² 	hours to level/compact excavated surface; state plant type & output;	cost to level/ compact;
	ii) Granular beds; per defined compartment; state total bulked m ³ to be handled and average	hours to transport, place and compact hardcore;	cost to transport, place and compact hardcore;
	depth; type of material described	Extra Over: for forming sinkings and/or packing unsupported edge; reduced for hardcore omitted; per defined length/ compartment;	cost for forming sinkings and/or packing unsupported edge adjusted for hardcore omitted; per defined length or compartment;
In Nr		hours to transport, place and compact blinding bed; including any mixing;	cost to transport, place and compact blinding bed; including any mixing;
In Nr	iii) Damp-proof membranes; per defined compartment;	hours to transport, roll out & joint sheet materials	cost to transport, roll out & joint sheet materials;
In Nr	iv) Reinforcement; per defined compartment;	hours to transport & place reinforcement including cutting, bending, tying, spacing as required; state bars or mesh;	cost to lay reinforcement all as direct labour;

WORK GROUP a) : Rafts & Beds

Cont'd

SUB-SECTION B : Sub-Structure ELEMENT II : Rafts & Beds (cont'd)

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
In m	(iv) Cont'd	Extra Over: for reinforcement in kickers;	
In Nr		Extra Over: for forming expansion joints; per defined joint;	
	v) Edge formwork; per defined compartment; stating average depth;	measured as earthwork support, see 1.A.II.a)ii)	as earthwork support, see 1.A.II.a)ii)
In Nr	including kickers & expansion joints;	hours for placing formwork to face not at the edge of the raft/bed, eg step, internal face of wall or column kicker etc; each face identified;	cost for placing formwork not at edge of foundation;
· ·	vi) Concrete; per defined compartment; stating plan area and total m ³ bulked quantity required	hours to transport, place & compact concrete; state reinforced/plain;	cost to transport, place & compact concrete; state reinforced/plain;
		Extra Over: for inserting (described) void formers	Additional cost to insert (described) void formers
In Nr		Extra Over: for casting in bolts, fixings and the like;	Additional cost for casting in bolts, etc.

WORK GROUP a) : Rafts & Beds (Cont'd)

NOTES:

1. Imported deep fill under slabs may be measured in loads of bulked material if more appropriate to on site management.

SUB-SECTION B : Sub-Structure ELEMENT III : Frames & Walls

Unit of Measurement	Work Piece Item	Directly Employed Labour and/or Plant	Sub-contract Labour and/or Plant
	i) Formwork; to defined column or beam; state lift and dimensions;	measured as carthwork support 1.A.II.a)ii);	as earthwork support a.A.II.a)ii)
In Nr		Extra Over: for beam & column joint; junction identified;	Additional cost for beam & column joint; junction identified;
	ii) Reinforcement; to defined column or	all as 1.B.III.a)iv)	all as 1.B.III.a)iv)
In Nr	beam, state lift & number & average size of bars & stirrups;	Extra Over: for beam & column joint; junction identified;	Additional cost for beam & column joint; junction identified;
	iii) Concrete: defined column or beam; state approximate m3 & lift;	hours to transport, lift, place & compact concrete;	cost to transport, lift, place & compact concrete;
In Nr		Extra Over: for casting in bolts, fixings and the like;	Additional cost for casting in bolts, fixings;
	iv) Precast concrete; defined column or beam state lift & unit dimensions:	hours to transport, lift and fix precast unit;	cost to transport, lift and fix precast unit;
In Nr		Extra Over: for beam and column joint;; junction identified;	Additional cost for beam & column joint; junction identified;
1	1	1	

WORK GROUP a) : Concrete Frames (including casing steelwork)

```

Contd....

.,\*

## SUB-SECTION B : Excavation & Groundworks ELEMENT III : Frames & Walis (cont'd)

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                         | Directly Employed<br>Labour and/or Plant                                                                                                                  | Sub-contract<br>Labour and/or Plant                                                          |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| In<br>M<br>lift        | i) Walls: per defined<br>wall run; state total<br>construction, e.g.<br>100mm block internal<br>skin, 60mm cavity lean<br>mix fill, half brick<br>commons external skin | hours for<br>construction of<br>described wall run;<br>include for face-<br>work & pointing as<br>required                                                | cost per metre lift of<br>described wall<br>including facework<br>& pointing as<br>required; |
|                        | ii) Adjustments to<br>masonry walls; state<br>wall &lift in which they<br>occur as follows:                                                                             |                                                                                                                                                           |                                                                                              |
| In<br>Nr               | - Forming openings<br>(identified)                                                                                                                                      | hours as required<br>for<br>close cavity; form<br>sills; fix DPCs;<br>build in lintols/<br>doors/windows;<br>minus hours wall<br>construction<br>omitted; | cost to form<br>opening;<br>allowances as for<br>direct labour                               |
| In<br>M<br>lift        | - Piers, chimneys &<br>like vertical work<br>(identified)                                                                                                               | hours to build<br>including cutting,<br>bonding, forming<br>& lining flues,<br>adjustment in work<br>to back wall & all<br>cappings/pots etc.             | cost complete as for<br>direct labour;                                                       |
| In<br>Nr               | - Decorative bands,<br>plinths, recesses &<br>like horizontal work;<br>(identified)                                                                                     | hours over and<br>above wall<br>construction to<br>form surface<br>features;                                                                              | cost over and above<br>wall to form surface<br>features;                                     |
| In<br>M<br>lift        | - Bonding to other<br>structures; method<br>stated; joint/s<br>identified;                                                                                              | hours for cutting &<br>bonding method<br>stated;                                                                                                          | cost for described<br>bonding;                                                               |

# WORK GROUP b) : Masonry Walls

Contd/....

## SUB-SECTION B : Excavation & Groundworks ELEMENT III : Frames & Walls (cont'd)

| Unit of<br>Measurement | Work Piece Item                     | Directly Employed<br>Labour and/or Plant                                                  | Sub-contract<br>Labour and/or Plant                  |
|------------------------|-------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------|
| In<br>Item             | - Builders work in connection       | hours for holes,<br>chases, building in<br>etc; stating<br>approximate sizes<br>& number; | cost for described<br>work as direct<br>labour;      |
| In<br>M                | - Damp proof courses<br>(described) | hours over & above<br>wall construction<br>for DPC;                                       | cost over and above<br>wall construction<br>for DPC; |

# WORK GROUP b) : Masonry Walls

#### SUB-SECTION B : Sub-Structure

#### **ELEMENT III : Frames & Walls**

| Unit of<br>Measurement  | Work Piece Item                                     | Directly Employed<br>Labour and/or Plant                                                         | Sub-contract<br>Labour and/or Plant                                                             |
|-------------------------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| In<br>lift<br>(defined) | i) Formwork; both<br>sides per defined<br>wall run; | hours as earthwork<br>support see<br>1.A.III.a)ii)                                               | cost as earthwork<br>support see<br>1.A.II.a)ii)                                                |
|                         |                                                     | Extra Over: for<br>placing (described)<br>void formers within<br>formwork void                   | Additional cost<br>for void formers<br>(described) within<br>formwork void;                     |
| In<br>lift              | ii) Reinforcement; per<br>defined wall run;         | hours as Rafts &<br>Beds; see<br>1.B.III.a)iv)                                                   | cost as Rafts &<br>Beds; see<br>1.B.III.a)iv)                                                   |
| In<br>lift              | iii) Insitu concrete;<br>per defined wall<br>run;   | hours to transport,<br>lift, place &<br>compact concrete;                                        | cost to transport,<br>lift, place &<br>compact concrete;                                        |
|                         |                                                     | Extra Over: for<br>placing void<br>formers in exposed<br>concrete face;                          | Additional cost<br>for placing void<br>formers in exposed<br>concrete face;                     |
|                         |                                                     | Extra Over: for<br>casting in bolts,<br>fixings etc in<br>exposed concrete<br>face;              | Additional cost<br>for bolts fixings etc<br>cast in exposed<br>concrete face;                   |
| In<br>lift              | iv) Precast wall units;<br>per defined wall<br>run; | hours to transport,<br>lift, place and fix<br>(described) precast<br>units; including<br>joints; | cost to transport,<br>lift, place and fix<br>(described) precast<br>units; including<br>joints; |

#### WORK GROUP c) : Concrete Walls

ANY OTHER CONSTRUCTION WORK REQUIRED TO BE MEASURED AS SUB-STRUCTURE SHOULD BE MEASURED IN ACCORDANCE WITH THE APPROPRIATE SUPER-STRUCTURE RULES.

# 9.3 SUPER-STRUCTURE

## SECTION 2 : SUPER-STRUCTURE

## SUB-SECTION A : Structural Shell ELEMENT I : Load Bearing Walls & Frames

# WORK GROUP a) : Concrete Frames (including casing steelworks)

| Unit of<br>Measurement                | Work Piece Item                                                                                                    | Directly Employed<br>Labour and/or Plant                                                                         | Sub-contract<br>Labour and/or Plant                                             |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
|                                       | i) Formwork; to<br>defined column or<br>beam; state lift and<br>dimensions;                                        | hours for labour to<br>collect make up and<br>fix support; state<br>first or subsequent                          | cost to collect, make<br>up & fix support;<br>state first or<br>subsequent use; |
|                                       | <br>                                                                                                               | hours to strike &<br>set aside;                                                                                  | cost to strike & set<br>aside;                                                  |
|                                       |                                                                                                                    | hours for disposal;<br>method stated, eg<br>return to store;<br>burn; etc.                                       | cost for disposal;<br>method stated;                                            |
| In<br>Nr                              |                                                                                                                    | Extra Over: for<br>beam & column<br>joint; junction<br>identified;                                               | Additional cost<br>for beam column<br>joint; junction<br>identified;            |
| · · · · · · · · · · · · · · · · · · · | ii) Reinforcement; to<br>defined column or<br>beam state lift &<br>number & average<br>size of bars &<br>stirrups; | hours to transport<br>& place<br>reinforcement<br>including cutting,<br>bending, tying &<br>spacing as required; | cost to lay<br>reinforcement all as<br>direct labour;                           |
| In<br>Nr                              |                                                                                                                    | Extra Over: for<br>beam & column<br>joint; junction<br>identified;                                               | Additional cost<br>for beam & column<br>joint; junction<br>identified;          |
|                                       | <ul> <li>iii) Concrete; defined<br/>column or beam;<br/>state approximate<br/>M<sup>3</sup> &amp; lift;</li> </ul> | hours to transport,<br>lift, place &<br>compact concrete;                                                        | cost to transport,<br>lift, place &<br>compact concrete;                        |
| In<br>Nr                              |                                                                                                                    | Extra Over: for<br>casting in bolts,<br>fixing and the like;                                                     | Additional cost<br>for casting in bolts,<br>fixings;                            |
|                                       | iv) Precast concrete;<br>defined column or<br>beam state lift & unit                                               | hours to transport,<br>lift & fix precast<br>unit;                                                               | cost to transport, lift<br>& fix precast unit;                                  |
| In<br>Nr                              | aimensions;                                                                                                        | Extra Over: for<br>beam & column<br>joint; junction<br>identified:                                               | Additional cost<br>for beam & column<br>joint; junction<br>identified:          |

## SUB-SECTION A : Structural Shell ELEMENT I : Load Bearing Walls & Frames

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                         | Directly Employed<br>Labour and/or Plant                                                                                                                    | Sub-contract<br>Labour and/or Plant                                                          |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| In<br>M<br>lift        | i) Masonry; to defined<br>wall run; state total<br>construction eg. 100mm<br>block internal skin, 60mm<br>cavity lean mix fill, half<br>brick commons external<br>skin; | hours for<br>construction of<br>described wall run;<br>include for<br>facework &<br>pointing as<br>required;                                                | cost per metre lift of<br>described wall<br>including facework<br>& pointing as<br>required; |
|                        | ii) Adjustments to masonry<br>walls; state wall & lift in<br>which they occur as<br>follows:                                                                            |                                                                                                                                                             |                                                                                              |
| In<br>Nr               | - Forming openings<br>(identified)                                                                                                                                      | hours as required<br>for:- close cavity;<br>form sills; fix<br>DPCs; build in<br>lintols/doors/<br>windows; minus<br>hours wall<br>construction<br>omitted; | cost to form<br>opening;<br>allowances as fir<br>direct labour;                              |
| In<br>M<br>lift        | - Piers, chimneys & like<br>vertical work (identified)                                                                                                                  | hours to building<br>including cutting,<br>bonding, forming<br>& lining flues,<br>adjustment in work<br>to back wall & all<br>cappings/pots etc;            | cost complete as for<br>direct labour;                                                       |
| In<br>Nr               | - Decorative bands,plinths,<br>recesses & like<br>horizontal work;<br>(identified)                                                                                      | hours over and<br>above wall<br>construction to<br>form surface<br>features;                                                                                | cost over and above<br>wall to form surface<br>features;                                     |
| In<br>M<br>lift        | - Bonding to other<br>structures; method<br>stated; joint/s identified;                                                                                                 | hours for cutting & bonding method stated;                                                                                                                  | cost for described bonding;                                                                  |

# WORK GROUP b) : Masonry Walls

Contd/...

## SUB-SECTION A : Structural Shell. ELEMENT I : Load Bearing Walls & Frames (cont'd)

| Unit of<br>Measurement | Work Piece Item                           | Directly Employed<br>Labour and/or Plant                                                  | Sub-contract<br>Labour and/or Plant             |
|------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------|
| In<br>Item             | - Builders work in connection;            | hours for holes,<br>chases, building in<br>etc; stating<br>approximate sizes<br>& number; | cost for described<br>work as direct<br>labour; |
| In<br>Nr               | - Building in fixing as<br>work proceeds; | hours for building<br>fixing eg. joist<br>hangers;                                        | cost for building in fixings;                   |

# WORK GROUP b) : Masonry Walls

# SUB-SECTION A : Structural Shell ELEMENT I : Load Bearing Walls & Frames

| Unit of<br>Measurement    | Work Piece Item                                                            | Directly Employed<br>Labour and/or Plant                                                                                                  | Sub-contract<br>Labour and/or Plant                                                             |
|---------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| In<br>lift                | i) Formwork; both sides<br>per defined wall run;<br>(including ends where  | hours as concrete<br>frames see<br>2.A.I.a)i) above                                                                                       | cost as concrete<br>frames see<br>2.A.I.a)i) above                                              |
| (lift must be<br>defined) | ариорпас)                                                                  | Extra Over: for<br>placing (described)<br>void formers within<br>formwork void;                                                           | Additional cost<br>for void formers<br>(described) within<br>formwork void;                     |
|                           |                                                                            | Extra Over: for<br>placing bolts,<br>fixings & the like<br>within formwork<br>void;                                                       | Additional cost<br>for placing bolts etc<br>within the<br>formwork void;                        |
| In<br>lift                | ii) Reinforcement; per<br>defined wall run;                                | hours to transport<br>& place reinforce-<br>ment including<br>cutting, bending,<br>tying & spacing as<br>required; state<br>mesh or bars; | cost to lay<br>reinforcement all as<br>direct labour;                                           |
| In<br>Nr                  |                                                                            | Extra Over: for<br>forming expansion<br>joints; per defined<br>joint;                                                                     | Additional cost<br>for forming<br>expansion joints;                                             |
| In<br>lift                | iii) Insitu concrete; per<br>defined wall run; state<br>approximate M3 per | hours to transport,<br>lift, place &<br>compact concrete;                                                                                 | cost to transport,<br>lift, place &<br>compact concrete;                                        |
|                           |                                                                            | Extra Over: for<br>placing void<br>formers in exposed<br>concrete face;                                                                   | Additional cost<br>for placing void<br>formers in exposed<br>concrete face;                     |
|                           |                                                                            | Extra Over: for<br>casting in bolts,<br>fixings etc in<br>exposed concrete<br>face;                                                       | Additional cost<br>for bolts, fixings<br>etc. cast in exposed<br>concrete face;                 |
| In<br>lift                | iv) Precast wall units<br>(described); per defined<br>wall run;            | hours to transport,<br>lift, place & fix<br>(described) precast<br>units; including<br>joints;                                            | cost to transport,<br>lift, place and fix<br>(described) precast<br>units; including<br>joints; |

# WORK GROUP c) : Concrete Walls

# SUB-SECTION A : Structural Shell ELEMENT II : Suspended Floors & Roofs

| Unit of<br>Measurement | Work Piece Item                                                                                                        | Directly Employed<br>Labour and/or Plant                                                                                   | Sub-contract<br>Labour and/or Plant                                       |
|------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| In<br>Nr               | i) Wall plates; per defined<br>wall run;                                                                               | hours to transport,<br>cut, lift & fix wall<br>plate including<br>bedding; jointing &<br>fixing straps;                    | cost to transport &<br>fix wall plates all as<br>direct labour;           |
| In<br>Nr               | ii) Carcassing timbers;<br>list timbers eg. joists<br>rafters, purlins, etc.<br>per defined floor/roof<br>compartment; | hours to transport,<br>cut, lift & fix listed<br>timbers; including<br>bedding, building<br>in or fixing joist<br>hangers; | cost to transport &<br>fit all carcassing<br>timbers as direct<br>labour; |
| In<br>Nr               |                                                                                                                        | Extra Over: for<br>trimming openings<br>eg. stairwells;<br>method stated;                                                  | Additional cost<br>for trimming<br>openings as direct<br>labour;          |
| In<br>Nr               | iii) Trussed rafters;<br>including ridges and<br>purlins; per defined<br>compartment; state<br>Nr of trusses;          | hours to transport,<br>lift and fix trusses<br>and other timbers as<br>described;<br>including cutting;                    | cost to fit trusses all as direct labour;                                 |

# WORK GROUP a) : Timber Floors & Roofs

Contd/....

### SUB-SECTION A : Structural Shell ELEMENT II : Suspended Floors & Roofs (cont'd)

| Unit of<br>Measurement | Work Piece Item                                                                                                                                    | Directly Employed<br>Labour and/or Plant                                                                                                              | Sub-contract Labour<br>and/or Plant                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| In<br>Nr               | <ul> <li>i) Soffit formwork; per<br/>defined floot/roof<br/>compartment; stating<br/>approximate area m<sup>2</sup></li> </ul>                     | hours as concrete<br>frames, see 2.A.I.a)i)<br>above                                                                                                  | cost as concrete<br>frames, see 2.A.I.a)i)<br>above                          |
|                        | each compartment                                                                                                                                   | Extra Over: for<br>placing (described)<br>void formers within<br>formwork void;                                                                       | Additional cost for<br>void formers<br>(described) within<br>formwork voids; |
|                        |                                                                                                                                                    | <b>Extra Over:</b> for<br>placing bolts, fixings<br>& the like within<br>formwork void;                                                               | Additional cost for<br>placing bolts etc.<br>within the formwork<br>void;    |
|                        |                                                                                                                                                    | Extra Over: for<br>edge formwork<br>(vertical) including<br>openings, upstands,<br>kickers & the like eg<br>wells & parapets<br>(incl. eaves soffit); | Additional cost for<br>placing edge<br>formwork as direct<br>labour;         |
| In<br>Nr               | <ul> <li>ii) Reinforcement; per<br/>defined floot/roof<br/>compartment; stating<br/>approximate area m<sup>2</sup><br/>each compartment</li> </ul> | hours to transport &<br>place reinforce-ment<br>including cutting,<br>bending, tying &<br>spacing as required;<br>state mesh or bars;                 | cost to lay reinforce-<br>ment all as direct<br>labour;                      |
|                        |                                                                                                                                                    | Extra Over: for<br>forming expansion<br>joints; per defined<br>joint;                                                                                 | Additional cost for<br>forming expansion<br>joints;                          |
| Ñr                     | iii) Insitu concrete; per<br>defined floot/roof<br>compartment; state                                                                              | hours to transport,<br>lift, place & compact<br>concrete;                                                                                             | cost to transport, lift,<br>place & compact<br>concrete                      |
|                        | approximate m <sup>3</sup> per<br>compartment;                                                                                                     | Extra Over: for<br>placing void formers<br>in exposed concrete<br>face;                                                                               | Additional cost for<br>placing void formers<br>in exposed concrete<br>face;  |
|                        |                                                                                                                                                    |                                                                                                                                                       |                                                                              |

# WORK GROUP b) : Concrete Floors & Roofs

Cont/d

#### SUB-SECTION A : Structural Shell ELEMENT II : Suspended Floors & Roofs (cont'd)

| Unit of     | Work Piece Item                                                                   | Directly Employed                                                                                                                                                                     | Sub-contract Labour                                                                                                                                                             |
|-------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measurement |                                                                                   | Labour and/or Plant                                                                                                                                                                   | and/or Plant                                                                                                                                                                    |
| In<br>Nr    | (iv) Precast slab units;<br>(described) per<br>defined floor/roof<br>compartment; | Extra Over: for<br>casting in bolts,<br>fixings etc. in<br>exposed concrete<br>face;<br>hours to transport,<br>lift, place and fix<br>(described) precast<br>units; including joints; | Additional cost for<br>bolts, fixings etc. cast<br>in exposed concrete<br>face;<br>cost to transport, lift,<br>place and fix<br>(described) precast<br>units; including joints; |

# WORK GROUP b) : Concrete Floors & Roofs (Cont'd)

## SUB-SECTION A : Structural Shell

## ELEMENT III : Steps & Staircases

| Unit of     | Work Piece Item                                                                                                                              | Directly Employed                                                                                           | Sub-contract Labour                           |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| Measurement |                                                                                                                                              | Labour and/or Plant                                                                                         | and/or Plant                                  |
| In<br>Nr    | i) Staircase (any<br>material); per flight<br>(identified) including<br>handrail/balustrades;<br>stating rise & Nr of<br>landings & winders; | hours to transport, lift<br>and fix staircase<br>complete; including<br>making up insitu if<br>appropriate; | cost to fix staircase all<br>as direct labour |

# WORK GROUP a) : Timber or Metal



SUB-SECTION A : Structural Shell ELEMENT III : Steps & Staircases

| Unit of<br>Measurement | Work Piece Item                                                                                            | Directly Employed<br>Labour and/or Plant                                                                                             | Sub-contract Labour<br>and/or Plant                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| In<br>Nr               | i) Formwork; per flight<br>(identified) listing<br>types required, eg<br>soffit, string & Nr of<br>risers; | hours as concrete<br>frames, see 2.A.I.a)i)<br>above;                                                                                | cost as concrete<br>frames, see 2.A.I.a)i)<br>above;                                         |
| In<br>Nr               | ii) Reinforcement; per<br>flight (identified);                                                             | hours to transport &<br>place reinforcement<br>including cutting,<br>bending, tying &<br>spacing as required;<br>state mesh or bars; | cost to lay reinforce-<br>ment all as direct<br>labour;                                      |
|                        |                                                                                                            | Extra Over: for<br>forming expansion<br>joints; per defined<br>joint;                                                                | Additional cost for<br>forming expansion<br>joints;                                          |
| In<br>Nr               | iii) Insitu concrete; per<br>flight (identified) state<br>approximate M3 per<br>flight.                    | hours to transport,<br>lift, place & compact<br>concrete;                                                                            | cost to transport, lift,<br>place & compact<br>concrete;                                     |
|                        |                                                                                                            | Extra Over: for<br>placing void formers<br>in exposed concrete<br>face;                                                              | Additional cost for<br>placing void formers<br>in exposed concrete<br>face;                  |
|                        |                                                                                                            | Extra Over: for<br>casting in bolts,<br>fixings etc. in<br>exposed concrete<br>face;                                                 | Additional cost for<br>bolts, fixings etc. cast<br>in exposed concrete<br>face;              |
| In<br>Nr               | iv) Precast stair units<br>(described) per flight<br>(identified)                                          | hours to transport, lift<br>and fix (described)<br>precast units,<br>including joints;                                               | cost to transport, lift,<br>place and fix<br>(described) precast<br>units; including joints; |
| In<br>Nr               | v) Handrail/balustrades<br>& the like; per flight<br>(identified);                                         | hours to transport, lift<br>& fix handrails,<br>balustrades and the<br>like complete;                                                | cost to transport, lift &<br>fix handrails,<br>balustrades and the<br>like complete;         |

# WORK GROUP b) : Concrete

.

.

## SUB-SECTION B : Non-Structural Components ELEMENT I : Non-Load Bearing Walls

| Unit of<br>Measurement | Work Piece Item                                                                                         | Directly Employed<br>Labour and/or Plant                                                                                                             | Sub-contract Labour<br>and/or Plant                                  |
|------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
|                        | i) Construct masonry<br>wall; per defined non-<br>load bearing panel;<br>state type of<br>construction; | hours to construct<br>defined panel;<br>including facework &<br>pointing as required:                                                                | cost to construct<br>defined panel as direct<br>labour;              |
|                        |                                                                                                         | Extra Over: for<br>scribing to structural<br>member (identified)                                                                                     | Additional cost for<br>scribing to structural<br>member (identified) |
|                        | ii) Adjustments to non-<br>load bearing panel in<br>which they occur as<br>follows:                     | · ·                                                                                                                                                  | · ·                                                                  |
| In<br>Nr               | - Forming openings<br>(identified)                                                                      | hours as required for:<br>close cavity; form<br>sills; fix DPCs; build<br>in lintols/doors/<br>windows; minus<br>hours wall<br>construction omitted; | cost to form opening;<br>allowances as for<br>direct labour;         |
| In<br>Nr               | - Piers & the like<br>vertical work<br>(identified)                                                     | hours to build<br>including cutting,<br>bonding, facing as<br>required;                                                                              | cost complete as for<br>direct labour;                               |
| In<br>Nr               | - Decorative bands,<br>plinths, recesses and<br>the like horizontal<br>work; (identified)               | hours over and above<br>wall construction to<br>form surface features;                                                                               | cost over and above<br>wall to form surface<br>features;             |
| In<br>Nr               | - Bonding to other<br>structures; method<br>stated; joint/s<br>identified;                              | hours for cutting and<br>bonding method<br>stated;                                                                                                   | cost for described<br>bonding;                                       |
| In<br>Item             | - Builders work in connection                                                                           | hours for holes,<br>chases, building in<br>etc; stating approx.<br>sizes & number;                                                                   | cost for described<br>work as direct labour;                         |
| In<br>Nr               | - Other adjustments<br>(described)                                                                      | hours for other<br>described<br>adjustments;                                                                                                         | cost for other<br>described adjustments;                             |

# WORK GROUP a) : Masonry Walls

#### SUB-SECTION B : Non-Structural Components ELEMENT I : Non-Load Bearing Walls (Cont'd)

| Unit of<br>Measurement | Work Piece Item                                                                                       | Directly Employed<br>Labour and/or Plant                                         | Sub-contract Labour<br>and/or Plant                                                  |
|------------------------|-------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| In<br>Nr               | i) Timber framework in<br>defined partition<br>panel; stating<br>approximate net<br>length of timber; | hours to transport, cut<br>and fix timber in<br>framework;                       | cost to transport, cut<br>and fix timber in<br>framework;                            |
| In<br>Nr               | Toright of sillions,                                                                                  | Extra Over: for<br>fixing (identified)<br>timber plates to<br>structural member; | Additional cost for<br>fixing (identified)<br>timber plates to<br>structural member; |

## WORK GROUP b) : Timber Partitions

## **NOTES:**

- 1. Making up timber framework for partitions includes framing to openings, noggins and bracing as required.
- 2. Proprietary partitioning or cladding systems may be measured in accordance with the rules for timber framework where they are not to be executed by specialist sub-contractor.

# SUB-SECTION B : Non-Structural Components ELEMENT II : Joinery

# WORK GROUP a) : First Fix

|                        | ·                                                                                                                                                              |                                                                                                          |                                                                                                              |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Unit of<br>Measurement | Work Piece Item                                                                                                                                                | Directly Employed<br>Labour and/or Plant                                                                 | Sub-contract Labour<br>and/or Plant                                                                          |
|                        | i) Board & sheet<br>coverings; per defined<br>floor or roof compart-<br>ment; state method of<br>fixing;                                                       | hours to transport,<br>lift, cut & fix<br>coverings; including<br>trimming around<br>openings;           | cost to transport, lift,<br>cut and fix as direct<br>labour;                                                 |
|                        |                                                                                                                                                                | Extra Over: for<br>forming holes/notches<br>for services; state<br>approximate number;                   | Additional cost for<br>holes/notches for<br>services; state<br>approximate number;                           |
| In<br>Nr               |                                                                                                                                                                | Extra Over: for<br>protecting floor/roof<br>coverings;                                                   | Additional cost to<br>protect floor/roof<br>coverings;                                                       |
| In<br>Nr               | ii) Door/window frames;<br>per defined frame;<br>state method of fixing<br>including access hatch                                                              | hours to transport, lift<br>& fix door/window<br>frame;                                                  | cost to transport, lift &<br>fix door/window<br>frame;                                                       |
| ·                      | frames etc.                                                                                                                                                    | Extra Over: for<br>protecting door/<br>window frames;                                                    | Additional cost to<br>protect door/window<br>frame;                                                          |
| In<br>Nr               | iii) Timber framing for<br>ducts & the like; per<br>defined vertical lift or<br>horizontal run; state<br>method of fixing;                                     | hours to transport,<br>lift, cut and fix<br>framing timbers;                                             | cost to transport, lift,<br>cut and fix framing<br>timbers;                                                  |
| In<br>Nr               | iv) Timber battens for<br>dry lining/cladding &<br>the like; per defined<br>compartment; state<br>method of fixing and<br>approximate net<br>length of timber; | hours to transport,<br>lift, cut and fix<br>battening;                                                   | cost to transport, lift,<br>cut and fix battening;                                                           |
|                        | v) Insulation; per roof<br>floor compartment;<br>state method of<br>fiving:                                                                                    | hours to transport,<br>lift, lay & cut<br>insulation;                                                    | cost to lay insulation<br>all as direct labour;                                                              |
| In<br>Nr               |                                                                                                                                                                | Extra Over: for<br>working insulation<br>round service pipes &<br>the like; state<br>approximate number; | Additional cost for<br>working insulation<br>round service pipes &<br>the like; state<br>approximate number; |

# SUB-SECTION B : Non-Structural Components ELEMENT II : Joinery (Cont'd)

| WORK | GROUP | b) | : | Second | Fix |  |
|------|-------|----|---|--------|-----|--|
|      |       |    |   |        |     |  |

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                  | Directly Employed<br>Labour and/or Plant                                               | Sub-contract Labour<br>and/or Plant                                                     |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| In<br>Nr               | <ul> <li>i) Room trims eg. dado,<br/>skirting etc; per room<br/>compartment; state<br/>method of fixing &amp;<br/>approximate net<br/>length of trim;</li> </ul> | hours to transport, cut<br>& fix (described)<br>trims;                                 | cost to transport, cut<br>and fix (described)<br>trims;                                 |
|                        |                                                                                                                                                                  | Extra Over: for<br>mitres to moulded<br>sections; state<br>internal/external<br>angle; | Additional cost for<br>mitres to moulded<br>sections; state<br>internal/external angle; |
|                        | ii) Hang & ease doors/<br>windows/access                                                                                                                         | hours to fit door/<br>window as described;                                             | cost to fit door/<br>window as described;                                               |
| In                     | fixing ironmongery,<br>trims, architrave,<br>threshold & window                                                                                                  | Extra Over: for<br>glazing; method<br>stated;                                          | Additional cost to<br>glaze door/window;<br>method stated;                              |
| Nr                     | boards; (all listed)                                                                                                                                             | Extra Over: for<br>protecting door/<br>window as required;                             | Additional cost to<br>protect door/window<br>as required;                               |
| In<br>Nr               | iii) Casing to ducts & the<br>like; per lift or run as<br>2.B.II.a)iii)                                                                                          | hours to transport, cut<br>and fix duct casing;                                        | cost to fix duct casing as direct labour;                                               |
| In<br>Nr               | iv) Dry lining, timber<br>cladding & the like;<br>per defined compart-<br>ment;                                                                                  | hours to transport,<br>lift, cut and fix<br>covering;                                  | cost to fix covering all<br>as direct labour                                            |

.

#### SUB-SECTION B : Non-Structural Components ELEMENT II : Joinery (Cont'd) (Cont'd)

| Unit of<br>Measurement | Work Piece Item                                                                                                           | Directly Employed<br>Labour and/or Plant                                                          | Sub-contract Labour<br>and/or Plant                         |
|------------------------|---------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
|                        | i) Curtain rails; shelves;<br>and the like; including<br>battens; each                                                    | hours to transport, cut<br>and fix complete;                                                      | cost to fix as direct labour;                               |
| In<br>Nr               | identified; state<br>method of fixing;                                                                                    | Extra Over: for<br>holes etc for services;<br>state number;                                       | Additional cost for<br>holes for services;<br>state number; |
|                        | <ul> <li>ii) Cupboard units and<br/>the like (described);<br/>each identified; state<br/>method of fixing;</li> </ul>     | hours to transport, lift<br>& fix unit complete;<br>allow for making up<br>insitu if appropriate; | cost to fix units all as direct labour;                     |
| In<br>Nr               |                                                                                                                           | Extra Over: for<br>holes etc. for<br>services; state<br>number;                                   | Additional cost for<br>holes for services;<br>state number; |
| In<br>Nr               | iii) Worktops, counters<br>where not an integral<br>part of base unit; per<br>defined surface; state<br>method of fixing: | hours to transport, cut<br>and fit worktop;<br>including jointing as<br>required;                 | cost to fit worktop as direct labour;                       |
|                        | mounde of mang,                                                                                                           | Extra Over: for<br>holes etc for services;<br>state number                                        | Additional cost for<br>holes for services;<br>state number; |

# WORK GROUP c) : Fixtures and Fittings

# 9.4 EXTERNAL WORKS

# **SECTION 3 : EXTERNAL WORKS**

## SUB-SECTION A : DRAINAGE

# ELEMENT I : Pipe Runs

# WORK GROUP a) : Excavation and Groundworks

| Unit of     |                                                                                                                                                                                              |                                                                                                                                                                                                           |                                                                                                             |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Measurement | Work Piece Item                                                                                                                                                                              | Directly Employed<br>Labour and/or Plant                                                                                                                                                                  | Sub-contract<br>Labour and/or Plant                                                                         |
| In<br>m     | i) Excavate drain trench;<br>state maximum depth<br>and net m <sup>3</sup> quantity<br>each run separately;<br>(between manholes)<br>spoil placed beside<br>trench ready for<br>backfilling. | hours for<br>excavation and<br>operator; stating<br>plant type and<br>output                                                                                                                              | cost to excavate<br>trench                                                                                  |
| In<br>m     | ii) Earthwork support;<br>per defined drain run;<br>type of support<br>described;                                                                                                            | hours for labour to<br>collect, make up<br>and fix in position;<br>state first or<br>subsequent use;<br>hours to strike and                                                                               | cost to collect, make<br>up and fix in<br>position; state first<br>or subsequent use;<br>cost for disposal; |
| ·           |                                                                                                                                                                                              | set aside                                                                                                                                                                                                 | method stated                                                                                               |
| In<br>m     | <ul> <li>iii) Backfill drain<br/>trench; state material<br/>type and m<sup>3</sup> bulked<br/>quantity required; per<br/>defined drain run</li> </ul>                                        | hours to transport,<br>place and compact;<br>stating plant and<br>outputs<br>hours for<br>excavating from<br>temporary spoil<br>heaps stating total<br>bulked m3 to be<br>moved, plant type<br>and output | cost to backfill<br>including plant and<br>the use of<br>temporary spoil<br>heaps as required               |
| In<br>Load  | iv) Disposal; spoil off-<br>site; per defined load<br>size; total bulked m <sup>3</sup><br>quantity                                                                                          | hours to load and<br>dispose as 1.A.I<br>c)ii) and iii)                                                                                                                                                   | cost as 1.A.I.c)ii)<br>and iii)                                                                             |

# SUB-SECTION A : DRAINAGE

#### ELEMENT I : Pipe Runs

| Unit of<br>Measurement                | Work Piece Item                                                                                                                                  | Directly Employed<br>Labour and/or Plant                                                                                                                                                                                                                                                                                         | Sub-contract<br>Labour and/or Plant                                                        |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| In ·<br>m                             | i) Pipes including bed<br>and surround as<br>required; per defined<br>drain run; state type of<br>pipe and bed; length<br>measured over fittings | hours to collect,<br>transport (mix if<br>required) and place<br>pipe bed; stating<br>material type<br>hours to collect,<br>transport and lay<br>(including jointing)<br>drainage pipes<br>hours to collect,<br>transport (including<br>mixing if required)<br>and place pipe<br>surround or<br>haunch; stating<br>material type | cost to lay pipes<br>including bed and<br>haunch/surround<br>and all joints as<br>required |
| · · · · · · · · · · · · · · · · · · · | ii) Pipe fittings; per                                                                                                                           | hours to collect,                                                                                                                                                                                                                                                                                                                | cost for fitting all                                                                       |
| In<br>Nr                              | defined pipe run; list<br>fitting types and<br>numbers of each per<br>pipe run                                                                   | transport and fit<br>pipe fittings<br>adjusted as<br>necessary per type/s                                                                                                                                                                                                                                                        | pipe fittings<br>described                                                                 |

# WORK GROUP b) : Pipes

SUB-SECTION A : DRAINAGE ELEMENT II : Manholes and the like

# WORK GROUP a) : Excavation and Groundworks

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                                                     | Directly Employed<br>Labour and/or Plant                                     | Sub-contract<br>Labour and/or Plant       |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------|
| In<br>Nr               | i) Excavate pit for<br>identified manhole,<br>septic tank, interceptor<br>trap and the like;<br>stating approximate<br>dimensions and m <sup>3</sup> net<br>quantity including any<br>working space | hours for excavator<br>and operatives; per<br>plant type stating<br>outputs; | cost to excavate<br>each identified pit   |
| In<br>Load             | ii) Dispose of spoil off-<br>site; per defined load<br>size; total bulked<br>quantity                                                                                                               | hours to load and<br>dispose as topsoil<br>1.A.I.c) ii) and iii)             | cost as topsoil<br>1.A.I. c) ii) and iii) |
| In<br>Nr               | iii) Earthwork support;<br>each pit separately                                                                                                                                                      | hours all as<br>1.A.II.a) iii)                                               | cost all as 1.A.II a)<br>iii)             |
| In<br>Nr               | iv) Backfilling<br>excavations including<br>working space; state<br>material type; each pit<br>defined; stating bulked<br>m <sup>3</sup> quantity per pit                                           | hours all as 1.A.III<br>a) i)                                                | cost all as 1.A.III<br>a) i)              |
| In<br>Nr               | v) Hardcore beds; per<br>defined pit; state<br>bulked m <sup>3</sup> quantity to<br>be handled and average<br>depth                                                                                 | hours all as 1.B. II<br>a) ii)                                               | cost all as 1.B. II<br>a) ii)             |

#### SUB-SECTION A : DRAINAGE

Т

I

## ELEMENT II : Manholes etc (Contd)

-

| Unit of     | Work Piece Item                                                                                                       | Directly Employed             | Sub-contract                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------|
| Measurement |                                                                                                                       | Labour and/or Plant           | Labour and/or Plant          |
|             | i) Concrete in beds and<br>foundations each pit<br>defined; state total m <sup>3</sup><br>bulked quantity<br>required | hours all as 1.B.II<br>a) vi) | cost all as q.B.II<br>a) vi) |

# WORK GROUP b) : Foundations

## SUB-SECTION A : DRAINAGE

### ELEMENT II : Manholes etc. (Contd)

# WORK GROUP c) : Walls

| Unit of<br>Measurement | Work Piece Item                                                                                       | Directly Employed<br>Labour and/or Plant                                                                          | Sub-contract<br>Labour and/or Plant                  |
|------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| In<br>Lift             | i) Masonry walls; per<br>defined lift each<br>chamber separately;<br>state total construction<br>type | hours all as 1.B.III<br>b) i)                                                                                     | cost all as 1.B.III<br>b) i)                         |
|                        |                                                                                                       | Extra Over for<br>hours as required<br>for forming<br>openings for pipe<br>connections<br>including<br>connecting | cost to form<br>openings and<br>connecting pipes     |
|                        |                                                                                                       | Extra Over for<br>building in step<br>irons including<br>collecting and<br>transporting; Nr<br>stated             | cost for building-in<br>step irons; Nr<br>stated     |
| In<br>Lift             | ii) Precast concrete<br>units; state type and<br>number per chamber;                                  | Extra Over for<br>hours for forming<br>openings and<br>connecting pipes                                           | cost for forming<br>openings and<br>connecting pipes |
|                        |                                                                                                       | Extra Over for<br>building in step<br>irons including<br>collecting and<br>transporting; Nr<br>stated             | cost for building in<br>step irons; Nr<br>stated     |

## SUB-SECTION A : DRAINAGE

#### ELEMENT II : Manholes etc (Contd)

# WORK GROUP d) : Suspended Slabs and Covers

| Unit of<br>Measurement | Work Piece Item                                                                                                          | Directly Employed<br>Labour and/or Plant                                    | Sub-contract<br>Labour and/or Plant |
|------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------|
| In<br>Nr               | i) Soffit formwork;<br>per identified chamber;<br>stating approximate area<br>m2 per chamber                             | hours all as 2.A.II.<br>b) i)                                               | cost all as 2.A.II<br>b) i)         |
| In<br>Nr               | ii) Reinforcement; per<br>identified chamber<br>stating approximate area<br>m <sup>2</sup> each chamber                  | hours all as 2.A.II<br>b) ii)                                               | cost all as 2.A.II<br>b) ii)        |
| In<br>Nr               | iii) Insitu concrete; per<br>identified chamber;<br>stating approximate m <sup>3</sup><br>per chamber                    | hours all as 2.A.II.<br>b) iii)                                             | cost all as 2.A. II<br>b) iii)      |
| In<br>Nr               | iv) Precast concrete<br>suspended slab units;<br>(described) per<br>identified chamber                                   | hours all as 2.A.II<br>b) iv)                                               | cost all as 2.A. II<br>b) iv)       |
| In<br>Nr               | v) Manhole cover and<br>frame and similar;<br>material stated (eg cast<br>iron) and size given per<br>identified chamber | hours to collect,<br>transport, place in<br>position and bed as<br>required | cost to place and<br>bed            |

## SUB-SECTION B : PAVING ELEMENT I : Excavation & Groundworks

#### GENERALLY

The unit of measurement for paving works measured per defined compartment is as follows:

Roads and Paths - per metre length or road, stating width in description

Paved Area - enumerated stating approximate area m2 in description.

WORK GROUP a): Site Preparation

### NOTES

 Where site preparation works are required to be measured separately in a Pavings Bill, items of work should be measured in accordance with the appropriate rules as given in Section 1.A.I a)-d).

#### WORK GROUP b): Bulk Excavation

#### NOTES

- Bulk excavation to reduce the site levels will normally include excavation for kerbs and edgings. These need only be measured separately as trenches if the work sequence is not continuous, eg if different plant is required.
- 2) Bulk excavation is measured in accordance with Section 1.A.II a).

#### WORK GROUP c): Backfilling

#### NOTES

- 1) Any backfilling required to kerbs and edgings should be measured in accordance with 1.A.III a).
- Filling to make up levels over site is measured in accordance with 1.A.I d)
   iii) and included as a site preparation item.

# SUB-SECTION B : PAVING ELEMENT II : Beds & Sub-Bases

| Unit of<br>Measurement | Work Piece Item                                                                                                                                      | Directly Employed<br>Labour and/or Plant | Sub-contract<br>Labour and/or Plant |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------|
| In<br>m                | <ul> <li>i) Preparation of<br/>excavated surfaces; per<br/>defined compartment;</li> <li>Roads and Paths - state<br/>width of carriageway</li> </ul> | hours all as 1.B.II<br>a) i)             | cost all as 1.B.II<br>a) i)         |
| In<br>Nr               | Areas - state<br>approximate m <sup>2</sup> area<br>ii) Granular beds; per                                                                           | hours all as 1.B.II                      | cost all as 1.B.II                  |
|                        | defined compartment;<br>state total bulked m <sup>3</sup><br>quantity to be handled<br>and average depth; type<br>of material described.             | a) ii)                                   | a) ii)                              |
| In<br>m                | Roads and Paths - state width of carriageway                                                                                                         |                                          |                                     |
| In<br>Nr               | Areas - state<br>approximate m <sup>2</sup> area                                                                                                     | -<br>-                                   |                                     |

# WORK GROUP a) : Beds and Sub-Bases

# SUB-SECTION B : PAVINGS ELEMENT II : Pavings

.

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                                                                       | Directly Employed<br>Labour and/or Plant                                                                                             | Sub-contract<br>Labour and/or Plant |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| In<br>Nr               | i) Edge formwork; per<br>defined compartment;<br>stating average depth                                                                                                                                                | hours all as 1.B.II<br>a) v)                                                                                                         | cost all as 1.B.II<br>a) v)         |
| In<br>Nr               | ii) Reinforcement; per define compartment                                                                                                                                                                             | hours all as 1.B.II<br>a) iv)                                                                                                        | Cost all as 1.B.II<br>a).iv)        |
| In<br>m                | <ul><li>iii) Base course; type<br/>and thickness state; per<br/>defined compartment;</li><li>Roads and Paths: state<br/>width of carriageway</li></ul>                                                                | hours for labour<br>and plant; type and<br>output stated;<br>collect, transport<br>and lay insitu base<br>course including<br>mixing | cost to lay insitu<br>base course   |
| In<br>Nr               | Areas - state<br>approximate m <sup>2</sup> area                                                                                                                                                                      | Extra over for<br>labours; each<br>described, eg<br>dishing to gulley                                                                | cost for labours;<br>each described |
| In<br>m<br>In<br>Nr    | <ul> <li>iv) Top course; type<br/>and thickness stated,<br/>per defined<br/>compartment;</li> <li>Roads and Paths: state<br/>width of carriageway</li> <li>Areas: state<br/>approximate m<sup>2</sup> area</li> </ul> | hours all as 3.B.III<br>a) iii)                                                                                                      | cost all as 3.B.III<br>a) iii)      |
|                        |                                                                                                                                                                                                                       |                                                                                                                                      |                                     |

# WORK GROUP a) : Insitu Pavings

# SUB-SECTION B : PAVINGS ELEMENT II : Pavings (cont'd)

| Unit of             | Work Piece Item                                                                                                                                                                                                                       | Directly Employed                                                                       | Sub-contract                        |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------|
| Measurement         |                                                                                                                                                                                                                                       | Labour and/or Plant                                                                     | Labour and/or Plant                 |
| In<br>m<br>In<br>Nr | <ul> <li>i) Precast blocks,<br/>bricks, slabs, type and<br/>size stated; laying<br/>patterns described -</li> <li>Roads and Paths: state<br/>width of carriageway</li> <li>Areas: state<br/>approximate m<sup>2</sup> area</li> </ul> | hours to collect,<br>transport and lay<br>precast paving<br>units; including<br>cutting | cost to lay precast<br>paving units |

# WORK GROUP b) : Precast Pavings
## SUB-SECTION B : PAVINGS ELEMENT II : Pavings (cont'd)

| Unit of<br>Measurement | Work Piece Item                                                                                                                                                   | Directly Employed<br>Labour and/or Plant                                                                                            | Sub-contract<br>Labour and/or Plant                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| In<br>m                | i) Insitu concrete in<br>foundation; per defined<br>run; stating total m3<br>quantity to be handled                                                               | hours to mix,<br>transport and place<br>insitu concrete,<br>including<br>compacting                                                 | cost to lay insitu concrete                               |
| In<br>m                | ii) Precast kerbs or<br>edgings; per defined<br>run; including bedding,<br>and haunching                                                                          | hours to collect,<br>transport and lay<br>kerbs or edgings<br>including mixing,<br>transporting and<br>laying beds and<br>haunching | cost to lay kerb or<br>edging including<br>bed and haunch |
| In<br>m                | <ul> <li>iii) Backfilling with<br/>excavated material<br/>including topsoil;<br/>levelling and seeding or<br/>turfing as required; per<br/>defined run</li> </ul> | hours to transport<br>and place excavated<br>material including<br>excavating from<br>temporary soil<br>heaps                       | cost to backfill<br>behind kerbs or<br>edgings            |

## WORK GROUP c) : Kerbs and Edgings

#### SUB-SECTION C : LANDSCAPING ELEMENT I : EARTHMOVING

#### NOTES

\_ \_ \_

1) All earthmoving works required for landscaping are measured in accordance with the appropriate excavation works as described in the sub-structure section of the measurement.

## SUB-SECTION C : LANDSCAPE ELEMENT II : IMPORTED FILLING NOTES

1) Imported filling if required is measured in accordance with 1.A.I. d) iii).

## SUB-SECTION C : LANDSCAPING

#### ELEMENT II : Seeding and Planting

| Unit of<br>Measurement | Work Piece Item                                                                                                                                | Directly Employed<br>Labour and/or Plant                            | Sub-contract<br>Labour and/or Plant |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------|
| In<br>Nr               | i) Seeding; per defined<br>compartment stating<br>approximate m <sup>2</sup> area                                                              | hours to collect,<br>transport and<br>spread seed                   | cost to seed grassed<br>areas       |
| In<br>Nr               | ii) Turfing; per defined<br>compartment stating<br>approximate m <sup>2</sup> area                                                             | hours to collect,<br>transport and lay<br>turf including<br>rolling | cost to lay turf                    |
| In<br>Nr               | iii) Planting; per<br>defined compartment;<br>listing number of<br>shrubs and trees                                                            | hours to excavate,<br>collect, transport,<br>plant and backfill     | cost to plant shrubs<br>and trees   |
| In<br>Load             | iv) Disposal of<br>excavated material; per<br>defined compartment<br>per defined load size;<br>stating total bulked m <sup>3</sup><br>quantity | hours all as 1.A.I.<br>c) iii)                                      | cost all as 1.A.I c)<br>iii)        |

## WORK GROUP a) : Seeding and Planting

## **SUB-SECTION D : EXTERNAL STRUCTURES**

#### NOTES

1) All external structures are measured in accordance with the relevant sections in the Sub- and Super-structure sections.

#### 9.5 ALTERATIONS

#### 4. ALTERATIONS GENERALLY

- 1) All alteration works are measured as spot items in the order given in the measurement rules.
- 2) Temporary works such as shoring and dust screens should be measured with the items they are required for.
- 3) Disposal of rubble removed from an existing building is measured in loads as for excavated spoil. A load may mean skip, in which case transporting and placing in skip is measure with each item of work requiring the disposal of rubble.

## **SECTION 4 : ALTERATIONS**

## SUB-SECTION A : OPENINGS IN EXISTING WALLS ELEMENT I : FORMING

| Unit of<br>Measurement | Work Piece Item                                                                                           | Directly Employed<br>Labour and/or Plant                                                                                                                                                                                                                                          | Sub-contract<br>Labour and/or Plant                                                                    |
|------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| In<br>Nr               | i) Form opening in<br>existing wall; location<br>reference; state wall<br>structure; give opening<br>size | hours for labour<br>and plant for the<br>following as<br>required:<br>- Shoring,<br>- remove and<br>dispose of<br>existing<br>- cut out and insert<br>listed & wedge &<br>pin up<br>- prepare sill<br>- square jambs,<br>- collect, transport<br>and fit new door/<br>window etc. | cost for cutting out<br>and inserting<br>door/window or<br>other described<br>including making<br>good |
|                        |                                                                                                           |                                                                                                                                                                                                                                                                                   |                                                                                                        |

. .

,

## WORK GROUP a) : Forming Openings

## **SECTION 4** : ALTERATIONS

## SUB-SECTION C : OPENINGS IN EXISTING WALLS ELEMENT II : Blocking up

| Unit of     | Work Piece Item                                                                                                                                       | Directly Employed                                                                                                                                                                                                                                 | Sub-contract                                                                                                             |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Measurement |                                                                                                                                                       | Labour and/or Plant                                                                                                                                                                                                                               | Labour and/or Plant                                                                                                      |
| In<br>Nr    | i) Block up existing<br>opening; location<br>identified; wall<br>structure described;<br>size of opening and<br>type of existing fitting<br>described | hours for labour<br>and plant for the<br>following as<br>required:<br>- remove existing<br>fitting<br>- prepare opening<br>for blocking up<br>including cutting<br>out at jambs<br>- block up<br>openings<br>- wedge and pin up<br>under head<br> | cost for removing<br>existing fitting if<br>necessary and<br>blocking up<br>opening including<br>making good<br>finishes |

## WORK GROUP a) : Blocking up Openings

#### **SECTION 4 : ALTERATIONS**

## SUB-SECTION A : OPENING IN EXISTING WALLS ELEMENT III : Altering existing

| Unit of     | Work Piece Item                                                                                                                                                        | Directly Employed                                                                                                                                                                                                                                                                                          | Sub-contract                                                                   |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Measurement |                                                                                                                                                                        | Labour and/or Plant                                                                                                                                                                                                                                                                                        | Labour and/or Plant                                                            |
| In<br>Nr    | i) alter size of existing<br>opening; location<br>identified; wall<br>structure described, and<br>size of existing and new<br>opening stated; state<br>type of fitting | <ul> <li>hours for labour<br/>and plant for the<br/>following:</li> <li>remove existing<br/>fitting (described)<br/>and dispose</li> <li>prepare existing<br/>opening as<br/>required</li> <li>block up or<br/>enlarge as<br/>necessary</li> <li>collect, transport<br/>and fix new<br/>fitting</li> </ul> | cost for altering<br>existing opening<br>including making<br>good as necessary |

## WORK GROUP a) : Altering existing openings

#### **CHAPTER TEN : CONTENTS**

#### SUPPLEMENTARY INFORMATION FOR USE OF MEASUREMENT RULES

#### 10.1 Introduction

#### SECTION A : Generally

10.2 Supporting documents

.

10.3 Tolerances

#### SECTION B : Clarifications and Definitions

- 10.4 Abbreviations and terms used generally
- 10.5 Clarifications

#### SECTION C : Use of Method Statements

- 10.6 Definition
- 10.7 Minimum requirements

#### **SECTION D : Conclusions**

10.8 Conclusions

#### CHAPTER TEN

#### SUPPLEMENTARY INFORMATION FOR THE USE OF MEASUREMENT RULES

#### **10.1 INTRODUCTION**

In order to minimise the length of the measurement rules for Builders' Quantities much of the supplementary information giving explanations and clarifications required to enable the mode of use to be learnt was omitted. This explanation and clarification was documented as a separate reference chapter which can be consulted as and when required.

Contained in this Supplementary Information section are guidelines to the use of the measurement rules generally, explanations and definitions of terms and abbreviations used within the rules and clarification of the rules themselves.

The clarification section (vide infra 10.5) was numbered and referenced as the measurement rules themselves. This resulted in an erratic sequence as not all the measurement rules required clarification.

Section C outlines the use of method statements and the minimum amount of information to be given within such a statement.

#### A. GENERALLY

#### **10.2 SUPPORTING DOCUMENTS**

The measured quantity data will not 'stand alone', it must be supported by suitable drawn information. This may range from a rough site plan showing, for example, approximate locations and references of work pieces in the site preparation element, to working drawing details. Where adequate drawn information is not provided by the tender/contract documentation, sketches should be added by the contractors' estimator or surveyor as necessary to supplement the measured data.

#### **10.3 TOLERANCES**

The units of measurement in the measurement rules take into consideration the tolerances that exist within the construction industry. For example, where an item is measured in loads, it is important that all parties understand that the load size given is approximate. A load described as 6 tonne anticipates the use of a truck which may carry 5.5 tonnes to 6.5 tonnes when weighed with a full load, depending on the type of material carried. Likewise, Ready Mixed Concrete suppliers may state that they supply in  $6m^3$  loads. This may, in actuality, vary by as much as  $0.3m^3$  plus or minus.

#### **B. CLARIFICATIONS AND DEFINITIONS**

The following chapter contains the definitions of the terms used in the measurement rules and clarification of the method and scope of measurement.

#### **10.4 ABBREVIATIONS & TERMS USED GENERALLY**

- Bulked where quantity is given "bulked" it is the gross quantity of material including an allowance for the increase in volume due to handling.
- Compacted quantity given as "compacted" must include an allowance for the reduction in volume due to compacting in position.
- Described measurer to insert full description of item to be described including length, width, height/depth, type of structure (e.g. brick, timber, flat/pitch roof) as appropriate.
- Drop describes the progression of the works in the downwards vertical plane (depth). May be defined by a dimension, e.g. per 2m drop is the progression of the works downwards in 2m stages.

Extra over - adjustment for additional resources required to complete an item of work which is included in the measurement of a work piece item and which is substantially similar and undertaken during the same operation e.g. removing an obstacle within excavation may be described as the additional time for labour/plant above the time allowed for the operation of excavating

Identified - an item to be identified must be allocated a reference or location code which identifies its position on site/within the construction.

Lift - describes progression of the construction works in the upwards vertical plane (height). May be defined by a dimension e.g. per metre lift is the upward progression of the works measured in 1m stages.

Net quantity - where quantity is described as net it is the quantity represented by the finished work piece excluding waste and bulking factors.

Overall size - overall size: dimensions to be measured over openings, bands, piers, voids or the like and stated length, width, height/depth as appropriate.

Operative type - the type of labour to be used must be stated along with the payment rates. These may be given in a separate section and abbreviated as follows

| Labourer:  | Lbr £/hr                           |                  |  |  |
|------------|------------------------------------|------------------|--|--|
| Craftsman: | bricklayer                         | = Bklyr £/hr     |  |  |
|            | joiner                             | = jnr £/hr       |  |  |
|            | carpenter                          | = cpntr £/hr     |  |  |
|            | other                              | = stated £/hr    |  |  |
| Gangs:     | made up of craftsmen & labourers   |                  |  |  |
|            | state size; craftsmen first e.g.   |                  |  |  |
|            | 2+1; 2No сга                       | ftsmen + 1No 1br |  |  |
|            | 5+2; 5No craftsmen + 2No 1brs      |                  |  |  |
|            | payment rate for whole gang = £/hr |                  |  |  |

194

Payment rate may be expressed as buying unit for item of work e.g. per metre lift brickwork plus labours; per concrete slab including reinforcement, formwork etc.

Quoted

- a cost described as quoted is one for which a subcontractor or supplier has provided a quotation.
- Storey the distance between floor structures. Commences where work starts after the incorporation of the floor structure and ends where works breaks for the incorporation of the next floor structure.

#### **10.5 CLARIFICATIONS**

Various terms are used within the measurement rules to define the extent of work piece item. These terms are defined below and numbered in accordance with the measurement rules for ease of reference:

#### Sub-structure: A. Excavation & groundworks

I. Site preparation:

- a) Demolition: (generally)
  - Material to be salvaged may require more careful handling. This will involve additional labour time and must be itemised and costed.
    - Double handling material placed on one side and later removed to a temporary or permanent spoil heap will also require more labour time. Itemise as extra over.
  - Cleaning labour time allowed for cleaning material to be salvaged as appropriate.

## b) Remove vegetation: (ii) trees

Tree - where growth cannot be removed within continuous site clearance operation individual time must be allocated. Each tree to be identified with a code cross referenced to drawing. Tree group - trees situated closely together may be measured as a group and an assessment of time for removal for whole group made regardless of individual size. Each group must be allocated an identification code.

d) Cut & fill operations:

Generally - continuous earthmoving operation excavating from one location and depositing in a different location on the same site. Measured as a site preparation item as it is undertaken in order to level out the site prior to the commencement of the construction works. The operation includes spreading, levelling and compacting the deposited spoil. Double handling may occur if a temporary spoil heap is used and some disposal off site may be required. These works are measured within the same work piece item in the manner described. The quantity of spoil to be cut is measured net and the quantity of spoil to be moved, spread, levelled and disposed is measured as gross after bulking.

#### (II) Bulk excavation

a) Excavating (generally):

Working space - no minimum requirements for working space. Any allowance made depends upon contractors method of working and any client specification. Width of allowance must be stated in description.

Area of excavation - plan area as shown on drawings. All substructure excavation undertaken for each building or building type measured as single item (not deep excavation). Adjustments measured where additional cost is deemed necessary for example:

Excavation for trenches or bases below areas of reduced level undertaken in same operation but involving a bucket change and moving plant from one trench/base to next:

| Bulk exc'n Area Z = 500cm (net) £2.50/cm =       | £1250.00 |            |
|--------------------------------------------------|----------|------------|
| Add: 6No bases 2.00 x 2.00 x 1.00dp = 24cm (net) |          |            |
| Rate = £2.60/cm x 24cm =                         | £        | 62.40      |
| + £1.00ea moving plant x 6No =                   |          | 6.00       |
| Total                                            |          | <br>316.40 |

Adjustments are only made where additional cost is deemed to be involved. This reflects the estimators assumed method of working.

#### (I) Bulk Excavation

Deep excavation - defined by the type of plant to be used. Where the depth of the excavation is deeper than the maximum reach of an excavator standing at ground level the total excavation is classified as deep and measured in drops. The depth of each drop may be either the maximum reach of the plant assumed to be used (type must therefore be stated either in description or in method statement) or dictated by the method of supporting the sides of the excavation (usually dependent on the ground conditions) detailed in method statement.

Deep excavation: earthwork support - measured in compartment as above per drop. Where drops are identical may be multiplied in a summary with additional resources detailed per drop for jointing, moving, cleaning as appropriate.

Rock, paving and obstacles - materials within the excavation that require additional resources over and above those being used for the bulk excavation are classified as obstacles. The additional resources are identified and costed as extra over the bulk excavation item. The extent of the additional resources required to remove such obstacles may not be fully measurable prior to the commencement of the works (i.e. the situation that usually exists during the tender preparation stage). Therefore, this item carries considerable risk for the contractor where a fixed price is to be tendered and must be carefully considered. Compartment (earthwork support) - the excavation face to be supported in continuous run e.g. all four sides of square/ rectangle etc. A compartment may not necessarily have four sides or be the circumference of curved work. May be single face e.g. retaining wall.

Foundation trenches - where each side of trench is supported at same time and braced across the width of the trench, the compartment is deemed to be per wall run and the length of the trench the centre line or average length. Additional resources may be itemised for forming corners is deemed necessary.

Note: where additional labour resources are required due to substantial depth changes, the compartment may be redefined to begin and end at the depth change.

Support for ends, steps and the like are measured as additions to the trench support.

Sub-structure: B. Sub-structure

I. a). Foundations (excluding rafts):

Definition - including the construction of strip and trench fill footings, ground beams, pile caps, stanchion bases, cantilevered and any other supporting foundation structure with the exception of rafts which are essentially constructed as beds.

Preparation of excavated surfaces: Area of foundation -

- Strip/trench fill: plan area of foundation trench as defined for earthwork support.
- Ground beams: plan area between bases either each or per defined run e.g. per building elevation.

Pile caps/stanchion bases: each identified measured either separately or per defined run as above Other: defined run, each or compartment as applicable.

- iv) Shuttering compartment: as defined for earthwork support.
- $\Pi$ . a) Rafts and Beds

Generally

Compartment - the defined area of a compartment is the plan area between walls or structures forming the compartment edge. The compartment is measured over all sinkings, thickenings and voids the quantity of material laid and the resources required to form these are taken into account in an adjustment section of the work piece item measurement. Large or complex plan shape compartments may be divided into smaller areas for ease of measurement and identification but all compartments laid in a continuous operation must be measured in the same work piece item.

- III Frames and Walls below DPC level:b) Walls
  - Wall run the plan length of a wall per building elevation (side) or between corners if structural plan shape complex for external walls. Plan length of wall between cross walls or corners if plan shape complex for internal walls e.g.



#### FIGURE 10.1

Walls F & G may, if preferred, be measured as a single wall run.

Stepped walls:-

- level at either base or at DPC: the additional brick/blockwork is included as an adjustment to the wall run in either the first or last lift as appropriate to its position.

- stepped at base and at DPC level: the height from base to DPC is usually the same for each portion of the wall run, therefore no identification of the steps is required. If this is not the case, the wall run is divided between steps, each step becoming an identified wall run e.g. where a structure is cut into an embankment forming a split level building.

#### Super-structure: A. Structural shell

- I. Loadbearing walls:
  - b) Masonry walls:
  - i) Construct wall:
    - wall run as sub-structure above.
    - stepped walls all as sub-structure.
  - ii) Adjustments:
    - opening a void in the wall construction not formed for services e.g. door, window
    - airbricks: building in airbricks and the like not measured separately unless deemed to require additional labour resources. Must be itemised in material measurement however.
    - piers: deemed to include any thickening of the brick/ blockwork e.g. chimneys, buttresses, that are constructed with the wall in which they occur. Each identified with a location code and measured separately per defined lift and wall in which they occur.
      - decorative bands, plinths, recesses and the like: includes portion of the wall requiring additional labour resources not measured as an opening or pier. Each band, plinth, recess is allocated an identifying code and measured separately stating the wall and lift in which they occur.
      - bonding: where bonding to abutting walls requires additional labour resources (over and above those required to construct the wall) or where a wall is to be bonded to an existing structure, the additional resources are to be measured per lift stating the identifying code and the wall in which it occurs. The formation of

corners in walls may also be measured separately if deemed to require additional labour resources.

builders' work in connection with services: includes
building in pipes, ducts, fixings etc. for services e.g.
gas, electric, water, compressed air etc. Also includes
forming openings for subsequent fixing of services.
Each opening, chase etc. allocated a location code and
the additional labour resources measured per lift stating
the wall in which it occurs.

Note: builders' work undertaken after the completion of the brickwork is measured in a separate builders' work section.

- c) Insitu concrete walls:
- i) Formwork:
  - wall run: plan length of wall between corners per lift which may be storey height or between construction joints i.e. cast in single operation (not between day joints where work breaks only because of the finish of the working day).

#### (ii) Reinforcement:

- Materials: bars may be scheduled separately if preferred but must be cross referenced to labour measurement.
- (iii) Concrete:

Wall run: portion of wall defined as:

- between floors and adjacent walls (corners);
- between construction joints as above.

#### iv) Precast concrete:

Wall: defined as plan length of wall between floors and adjacent walls i.e. per storey height lift.

Joint: is construction joint not day joint and includes all labour resources required for inserting jointing and movement compounds.

- II Suspended Walls and Roofs
  - a) Timber floors and roofs:
  - ii) Carcassing timbers

compartment: defined as the plan floor area between structural walls/frame members. Door openings in structural walls are ignored and deemed to form part of the compartment boundary unless additional labour resources are required to lay floor structure into a door opening, this additional labour must be itemised stating the floor in which it occurs and allocated an identifying code.

Note: where a floor bears onto a supporting joist or dwarf support wall, the compartment is measured over this structure to the storey height loadbearing walls.

- opening: where structural timbers are trimmed to form an opening. Forming an opening is deemed to include all labour necessary for cutting and fitting trimmed, trimmer and trimming joists including forming joints.

#### (iii) Trussed rafters

roof compartment - plan area of roofing per pitch, (either mono or double) between changes in direction e.g. see Figure 10.2.

If compartments A and C are identical, only one needs to be measured in detail, the summary total can be doubled to allow costs for the second compartment.

- b) Concrete floors and roofs:
  - i) Soffit formwork:
  - opening: includes stairwells, hatchways and all ducts etc for services to be case into the floor. Any opening formed at a later date is measured in the appropriate section (builders' work or alterations etc).



#### FIGURE 10.2

iii) Insitu concrete:

compartment: defined by the placement of formwork between structural walls/frame members i.e. support for floor structure to be cast in a single operation between designed/movement joints.

Note: floors cast over secondary supporting beams are classified as a single compartment when undertaken in a single casting operation (see timber floors).

iv) Precast concrete:

compartment: floor structure between supporting walls/frame members as above.

#### III Steps and Staircases (generally)

- staircase: all treads and risers not constructed with the floor i.e. top riser and/or tread may be constructed with and as part of the floor structure, likewise landings.
- flight: a continuous run in the same direction i.e. between winders, landings etc. Each run of winders are measured in a winding flight stating the degree of turn (i.e. 45', 90') number of treads and rise. A spiral staircase is formed by a single winding flight. Landings within the flight (not part of floor structure) are detailed stating plan size and number. Where winders or landings are supported by newel posts, this support is measured with the staircase in which it occurs stating the total finished length and method of fixing.
- rails and balustrades etc.: where these are not a second fix item i.e. supplied fitted or fabricated integrally with the flight, the labour resources required for securing to wall/floor structure once the staircase is in position are detailed as a separate item within the work piece item of fixing the staircase of which they are a part.
- steps: defined as treads and risers constructed on a solid base e.g. filling material, brick etc. Steps do not have a soffit.
- per metre lift (entirely of brick or block): adjustments made for forming/facing treads and risers within each lift stating number.

#### Super-structure: B. Non-structural components

I. Non-Loadbearing walls: Definition - permanent or demountable dividing partitions which are non-loadbearing and not sub-contracted specialist works.

#### C. USE OF METHOD STATEMENTS

#### **10.6 DEFINITION**

A method statement compiled by the estimator, details the assumptions made during the estimating process about the contractors methods of working. These assumptions effect both the cost of the works and the items measured.

The estimators method statement supplements the measured data providing details of why certain items have or have not been measured, what buying units have been used for the labour (plant and materials if non-standard) etc. The estimators assumptions may not be implemented by the site manager but do provide a form of target within which the site manager must work if the contract is to be profitable. The site manager must decide whether to undertake all or part of the works in the manner assumed and costed by the estimator or whether to vary the assumed method to save cost and/or time.

The detail of the estimators method statement is a matter for individual company policy based on the known needs of the post-contract management functions, the type and size of the project and the tender information provided by the client. However, the minimum detail required for the use of the measurement rules for builders' quantities detailed in Chapter 6 is contained in the following section:

#### **10.7 MINIMUM REQUIREMENTS**

The following details must be stated and an indication of whether the details are assumed or known at the time of tender.

- a) Sub-structure: Excavation and groundworks
  - i) ground conditions
  - ii) excavating

- : method e.g. reduce level over site or excavate trenches etc;
- : number and types of plant or assumed maximum reach and output;
- : if sub-contracted state whether sub-contractor undertaking disposal.

| iii) | deep excavation | : | depth  | of     | assumed      | drop     | for   |
|------|-----------------|---|--------|--------|--------------|----------|-------|
|      |                 |   | excava | tion,  | shuttering   | etc;     |       |
|      |                 | : | metho  | d in   | cluding lo   | wering   | and   |
|      |                 |   | removi | ng p   | lant, shutte | ring etc | ;     |
| iv)  | disposal        | : | whethe | er ter | nporary sp   | oil heap | s are |
|      |                 |   | -      | -      |              |          | _     |

to be used, lorries loaded direct from excavation etc;

: assumed lorry load size e.g. 6 tonne etc;

: distance for tipping and charges.

- b) All other works:
  - Labour: type and size of labour gangs and cross reference with rates used in estimate e.g. each gang coded and costed in labour section, code only then needs to be used in estimate.
  - ii) Plant: number and types of plant, including hoisting/plant,scaffolding, prefabricated formwork etc.
  - iii) Assumed divisions: outline of items of work included in each measurement section, may be used as estimate summary or index etc.
  - iv) Method: any assumed method of working affecting the method of measurement and notes on advice received from site manager during estimating process.
  - v) Coding: locational coding must be used during the estimating to identify the work piece items, elements etc. It is recommended that these be cross-referenced on working drawings.

The estimator is required to provide any additional information which has affected the method of measuring and costing the works. It was recommended that the method statement be prepared with reference to the recommendations of the CIOB detailed in the Code of Estimating Practice page 36.

•

,

#### **SECTION D** : CONCLUSIONS

#### **10.8 CONCLUSION**

The explanations and clarifications including the setting down of the minimum requirements of a method statement complete the documentation of the measurement rules for Builders' Quantities.

Chapter 9 (The Measurement Rules) and Chapter 10 (Supplementary Information) stand alone as a user document for the measurement of Builders' Quantities and combined with the findings of the evaluation process detailed in Chapter 11 fulfill the primary objective of the research work.

#### **CHAPTER ELEVEN**

## **EVALUATION OF THE TESTED WORK**

- 11.1 Introduction
- 11.2 Estimating management function
- 11.3 Purchasing management function
- 11.4 Surveying management function
- 11.5 Planning management function
- 11.6 Site and higher management function
- 11.7 Conclusion

#### **CHAPTER ELEVEN**

#### **EVALUATION OF TESTED WORK**

#### **11.1 INTRODUCTION**

This chapter summarized the findings of the evaluation of the tested work. The methodology adopted for testing the measurement rules was described in chapter 3.8 and the methodology for the evaluation process in Chapter 3.9. The evaluation process resulted in the development of the measurement rules for Builders' Quantities detailed in Chapter 9 and the qualitative assessment of the implications of the work for contracting organizations is described in this Chapter. Each management function is considered in turn and the findings are taken from the interviews undertaken during the evaluation process detailed in Appendix E.

#### **11.2 ESTIMATING MANAGEMENT FUNCTION**

The use of the measurement rules was not generally felt to reduce the time taken for the preparation of estimates, mainly because of the consideration of location. This was the main disadvantage with the format for the presentation of the measured data.

Estimators felt that the simplicity of the measurement rules allowed a more comprehensive consideration of cost by documenting resource requirements rather than details of design technology. Indeed one estimator (John Grundy - Appendix E) felt that descriptions of measured work did not describe the resource requirements but rather the degree of difficulty of the work. The actual resource requirement was left to the discretion of the contractor. With Builders' Quantities, however, the resource requirements were described and the level of difficulty left to the judgement of the estimator. Grundy felt this was appropriate as "no matter how complicated a design, it can only be achieved by relatively simple labours, eg mixing, lifting, nailing etc" (see Appendix E). The level of difficulty was identified as involving one or more of the following:

- (i) more care in assembly, eg less tolerance;
- (ii) restricted accessibility, eg heavy reinforcement; and

#### (iii) greater protection of the work and/or materials.

In each case the time required for the labour resource was increased. This strengthened Grundy's theory that the labours themselves were relatively simple, just required to a greater or lesser extent. This theory operated within the trade skill bands in that, for example, no amount of bricklaying hours would install the electrical circuits. The construction work did need to be categorized within the specialist workmanship structure of trades that existed. This resulted in cost estimates that reflected resource requirements and easily incorporated the contractors' particular methods of construction and management.

A complaint from estimators about the use of Builders' Quantities was apparent in all the field tests, that was the availability of suitable cost data. Four of the five estimators preferred to use unit rates and it was felt that always pricing the basic resources was unnecessarily time consuming. However, when challenged on this (see Appendix E) all the estimators involved in the field tests admitted that the cost estimate achieved using Builders' Quantities was theoretically more accurate than using traditional Bills of Quantities. These estimators also agreed that the use of Builders' Quantities would become easier with practice, this would result in the collection of more useful cost data.

#### **11.2 PURCHASING MANAGEMENT FUNCTION**

All five purchasing representatives participating in the field tests felt that the data presented to them as Builders' Quantities was an improvement of data from traditional Bills of Quantities. The main advantages seen were as follows:

- a clear breakdown of waste calculations related to location and construction method allowed purchasers to assess material requirements more accurately. This had the effect of increasing the control over target costs and quantities potentially improving profit margins;
- (ii) the measurement of material resource separately made abstraction of material quantities easier. The use of Builder Quantities removed

the need for the purchaser to re-measure material quantities that existed with traditional Bills of Quantities;

(iii) the listing of material quantities related to their location within the building made it easier for the purchaser to check the quantities prepared by the estimator. This also removed the need to remeasure.

The only reservation expressed by three of the five participating purchasing representatives (Appendix E) was that they did not trust quantities prepared by anyone other than themselves. When asked whether the breakdown showing location helped cross reference the estimators quantities with drawn information, thus allowing a quick visual check without complete remeasurement, all three agreed that this would be the case. It was felt by the purchasers generally that confidence would grow with increasing use of the system.

It was estimated that the use of Builders' Quantities would result in a saving 1 How was of 12-28% of the purchasers' time. The average saving was thought to be  $\frac{1}{100}$ approximately 20%, but this would depend on the size and complexity of the project. The greatest savings were most likely to occur on large, complex projects where Builders' Quantities would provide simpler data than traditional Bills of Quantities.

# done?

#### **11.4 SURVEYING MANAGEMENT FUNCTION**

All the surveying representatives participating in the field tests felt that the Builders' Quantities could save 25-50% of surveying time by expressing the labour resource in its buying unit and related to location. Again, the greater time savings were thought to be found on the larger and more complex projects where a large proportion of the surveyors time was spent in breaking down and re-measuring the labour resource requirement. The average saving in time was estimated as 38%.

It was also thought that the presentation of measured data as advocated by the Builders' Quantities allowed much tighter control over costs as the targets prepared by the surveyor for the site manager could be directly compared with the estimators allowances. This meant that the estimate was

212

much more meaningful as a management tool when prepared as Builders' Quantities than with traditional Bills of Quantities.

#### 11.5 PLANNING MANAGEMENT FUNCTION

The benefit of Builders' Quantities to planners was not so significant as that derived by surveyors and purchasers. Although the listing of the measured data in a construction sequence did aid the logic of the programming, the hourly breakdown for directly employed and labour only sub-contractors did not really assist the process of expressing the work in terms of timebased units. This was mainly because planners still had to decide on which works could run concurrently and what intensity of labour was required. It was estimated that a saving of approximately 5% of planning time could be | based on under ? made by the use of Builders' Quantities.

#### 11.6 SITE AND HIGHER MANAGEMENT FUNCTIONS

As neither of the management functions used data that had not already been transformed by the other management functions, it was not thought that Builders' Quantities could contribute to the streamlining of their tasks.

However, one higher manager (John Walkerdine - Appendix E) did suggest that the process of assessing the margin at tender stage might be made simpler because the measure data reflected the proposed construction method and the anticipated resource requirements. Walkerdine thought that once the contracting organization was familiar with Builders' Quantities there were deeper implications for their application within the policy making decision processes of the higher management team.

#### 11.7 CONCLUSIONS

It can be concluded from the findings of the evaluation of the tested work that the contribution to the post-contract management process by the use of Builders' Quantities was considerable. It was estimated that there was an average saving of approximately 63% of staff time across the management functions. This had the consequence of providing management staff with more time to concentrate on the more productive aspects of their work, ie

those involved with monitoring expenditure and increasing profit, and eliminating the non-productive repetition and regeneration of measured data.

Builders' Quantities were thought to make the greatest contribution (in terms of streamlining the tasks) to the Surveying and Purchasing management functions, with a limited contribution to the Planning management function. These findings were anticipated and were plotted in a flow chart in Chapter Seven (see Figure 7.4).

No saving in time was found for the Estimating management function but no increase (outside the learning process) was shown either. The advantage offered by the use of Builders' Quantities was the opportunity to incorporate the effect of both location and construction method into the costs, as advocated by the CIOB Code of Estimating Practice. This had the effect of increasing the precision of the estimated costs which in turn improved the efficiency of the post contract management by providing more relevant and accurate base data.

The use of Builders' Quantities required greatest change in the approach to the performance of the Estimating management function by presenting measured data in a different format. This format was much more familiar to the other management functions.

It was thought that Builders' Quantities had beneficial implications for the basis of decision making by higher management. The full consequences of this were not pursued within this research project.

## **CHAPTER TWELVE : CONTENTS**

## SUMMARY AND CONCLUSIONS

| 12.1 | Summary                    |
|------|----------------------------|
| 12.2 | Conclusions                |
| 12.3 | Significance of results    |
| 12.4 | Scope for further research |
| 12.5 | Publications               |
| 12.6 | Reports                    |
| 12.7 | Proposed Publications      |
| 12.8 | Work Files                 |

#### **CHAPTER TWELVE**

#### SUMMARY AND CONCLUSIONS

#### **12.1 SUMMARY OF RESEARCH FINDINGS**

A summary of the findings made during the four year research period were listed as follows:

- i) Previous literature dealt mainly with attempts at revising contract documentation and not specifically with the internal use of data within contractor organisations.
- ii) The documents most influencing the use of measured data were found to be the tender contract documents and these were prepared outwith the contracting organisation. Of the various forms of contract the Bill of Quantities type was found to be the most common and the effect of this form of contract documentation went beyond its own employment and was a major influence on the execution of management tasks undertaken for non-BQ contracts such as design/construct or specification and drawing contracts. The evidence was that, even in these non-BQ contracts, the contracting organisation re-created a bill of quantities, usually using the RICS standard method of measurement and frequently employing private practice quantity surveyors to produce it.
- iii) All forms of contract in use dealt with descriptions of the final work and no information was supplied in the contract documentation with regard to resources required during the construction.
- iv) Contracting organizations had a great need for quantitative data for their production management.
- v) The tasks relating to data use within contracting organisations were clearly identifiable and consistent between companies but the allocation of these tasks between the management functions (i.e. estimators, purchasers, planners etc.) undertaking them was not always the same.

- vi) All main function (estimators, planners, purchasers, site managers, surveyors and higher managers) used measured data and the measured data covered the seven sections of excavation, concrete work, brickwork, woodwork, drainage, external works and alterations. All other work was found to be sub-contracted and the sub-contractor dealt with the measured data for the sub-contract works.
- vii) A main flow of data from estimator and planner through the purchaser, site manager and surveyor was identified, together with a return flow of data from the site to the surveyor, purchaser, planner and higher manager. Other secondary flows between certain of the other management functions were identified along with data interfaces. Measured data was passed between the management functions of a construction company throughout the contract period as profit and progress were monitored and reported upon.
- viii) The allocation of resources by the surveyor, planner and purchaser and as used by the site manager were found to reflect individual construction stages of site working.
- ix) The first management function to be involved with measured data was the estimator and a method of compiling measured data for this function in non-BQ type contracts that could be used by the purchasers and site managers seemed attractive. However, for the estimator to undertake the task of providing a complete set of ordering schedules, for example, was shown to be impractical. Therefore, the aim was revised to defining a set of measurable builders' quantities for use by estimators that provided measured data in a format that could be used by the other management functions who could abstract their requirements without re-working the same information.
- x) Substantial amounts of data were passed within and between the management functions and that of this data, much had to be re-worked and regenerated in order for the management tasks to be performed successfully. This situation was evidenced by the following:
- a) The estimator assessed the total material content of the project but this assessment was expressed in the unit rate of the measured item. The purchaser had to abstract the quantities of materials to be used from the BQ and re-assess the wastage factor. This was done because it was easier to undertake the measurement of the material resource again than to attempt to abstract this information from the estimators resource breakdown.
- b) The planner also had to substantially transform the BQ data to establish the time spans for the various construction operations in order to compile the programme. This was done from the drawings with limited reference to the measured data, again it was easier to undertake the assessment of time spans from scratch than to attempt to abstract the required information from the estimate and convert this information into hours/days etc. Once the time spans had been established, this information was then related back to the BQ data in order to draw up the programme.
- c) At the time of the research, the site manager made very little use of the BQ data. The existing format of client prepared BQs made it virtually impossible, without large amounts of reworking of data, for them to be of use to the site. They contained no information relating to the method of construction at all. If the BQs were used by the site manager, it was as a specification for the quality of materials and workmanship. Measured data was used by the site manager in the form of resource targets prepared by the surveyor and purchaser, but this data bore little resemblance to the BQ data.
- d) The surveyor did use the BQ data without transformation when preparing valuations and final accounts for presentation to the client. Any variations to the contract had to be measured on-site and the data re-worked into the BQ format for the benefit of the client. The preparation of resource targets for the site manager involved the regeneration of measured data, often from the drawings, with cost data being abstracted from the estimate. As

the estimate was, in many cases, prepared in BQ format, the abstraction of this cost data required considerable re-working of the information prepared by the estimator as well as the regeneration of information received from the client.

- xi) The base units for the quantities of resources required for use by the management functions were found to be hours/days/weeks for the labour and plant resources and the purchasing units for the material resource, although these base units for the labour resource may be expressed as compound items of work.
- xii) The resources could be grouped in accordance with the working stages during the preparation of the tender by the estimator to provide a management document for use by the post-contract management functions.
- xiii) Considerable savings in the time required by the contractors' management personnel to perform their management asks were revealed during the evaluation of the use of Builders' Quantities.

## 12.2 CONCLUSIONS

The major conclusion to the research was that a method of preparing measured data could be compiled that reduced the amount of re-working and re-generating of measured data observed during the post-contract management of construction works. This method was written down as a set of measurement rules that formed a proven prototype.

It was estimated by the participating contractors' management personnel that the use of Builders' Quantities offered the following savings in time and consequently overhead cost:

consequently overhead cost: Doil Carteard get paid for it. 7

| Estimators        | Nil          |      |      |
|-------------------|--------------|------|------|
| Purchasers        | 12% - 28%    | av.  | 20%  |
| Surveyors         | 25% - 50%    | av.  | 38%  |
| Planners          | 5%           | av.  | 5%   |
| Site Management   | Nil          |      |      |
| Higher Management | To be asses  | ssed |      |
|                   | Total savin  |      | 6304 |
|                   | 1 0(41 54410 | Bo.  | 0370 |

The prototype measurement rules had established the following main principles of measurement for Builders' Quantities:

- i) The measured builders' quantities should be presented in such a way that the total quantities of resources to be used can be costed and allocated for the performance of the management tasks required during the post-contract management of the construction works without substantial re-working of measured data.
- ii) The units of measurement should reflect the actual buying units for each resource.
- iii) A method statement should be prepared that supplements the measured data and indicates assumptions made by the estimator about the method of working.

It could be seen therefore that the initial hypothesis was correct, compensating work was observed to have been undertaken and that this compensating could be reduced by a revised method of data preparation.

## **12.3 SIGNIFICANCE OF RESULTS**

The development of a set of measurement rules based on Builders' Quantities filled a gap in the construction industry that had long been identified. The shortfall in existing methods of contract procurement was identified by Sumner-Smith in 1920's, BRE in the 1960's, the BPF in 1980's and by the RICS during the preparation of SMM7. The only body that had advocated a method of preparing measured data was the RICS. However, although the brief for the development of SMM7 was to provide a flexible method of measurement that aided contractors, a review published in the Chartered Quantity Surveyor magazine (April 1988) concluded that SMM7 fell short of this brief.

The method of measurement developed during this research examined the requirements of the contractors management functions and based the method of preparing measured data on these requirements. The use of buying units as the unit of measurement and the placement of the measurement emphasis on the labour resource, formed a considerable departure from traditional methods of measuring where the emphasis was placed on the measurement of materials and the units of measurement the net length, area or volume of material to be incorporated.

A further area of significance identified was the consequences of streamlining the post-contract management on the decision making process of the higher management function. The full significance of this formed an area for further research.

The method of making the industry at large aware of the research will be limited to the method of publication of the results. The actual and anticipated publication of papers and articles are outlined below. The development of the project was continued at Moratuwa University, Sri Lanka, where the measurement procedures were further streamlined to suit the Sri Lankan construction industry.

## **12.4 SCOPE FOR FURTHER RESEARCH**

The following areas were identified as providing scope for further research:

## (i) Impact on high management executive decision making

That the use of Builders' Quantities could have an effect on executive decision making was identified. The definition and extent of this effect was not examined during this research project and an investigation into this effect will lead to the development of decision support systems for use at an executive level.

## (ii) Low cost computer applications

In order to maximise the benefit offered by streamlining data flow within contracting organizations use should be made of the sorting facilities available with computer database and spreadsheet applications.

It is important that such low cost and readily available packages are used as the small and medium sized contracting organizations at which this work is aimed are unlikely to have the resources to justify the purchase of computer hard and software.

It is suggested that a commercial application for the results of this research could be found via the adaptation of proprietary databases and spreadsheet packages.

## (iii) Commercial computer software packages

It is anticipated that the measurement rules may find an application as a "front end" to existing commercial estimating and contract management packages. However, this application and that outlined in (ii) above would probably be mutually exclusive due to copyright.

## (iv) Measurement Rules for sub-contract packages

The work undertaken for this project confined itself to construction work undertaken by the main contractor using directly employed or labour only subcontractors. No attempt was made to examine the requirements of subcontractors (whether domestic or nominated). As sub-contract works exist on every project to some extent, the production of measurement rules to aid their management function would have a potentially wide application.

## **12.5 PUBLICATIONS**

Some of the work undertaken for this research project has been written up for publication. A list of papers and articles prepared follows with the publishing details as appropriate. Copies of the journal articles are contained in Appendix F.

- 1. Refereed Papers published by the International Journal of Construction Management and Technology: Authors - McCaffer & Pasquire.
  - Interchange and Use of Measured Data by Contractors Management Functions: Volume 2, No.4 November 1987.
    - Considerations and Principles of Measurement for Builders' Quantities: accepted May 1988; not published due to change of publisher.
- 2. Conference Paper: Bills of Quantities Are They Needed? Written and presented by Pasquire at:
  - RIBA/CICA conference, Barbicon Centre, London, January 1987;
  - CIOB/CICA conference, Manchester, February 1988.
- 3. Articles: Author Pasquire
  - series of six articles published by Building Magazine April/May
    1985: survey of currently available software for the preparation
    and use of measured data for the construction industry.
  - Bills of Quantities Are they Needed?: published Building Technology and Management July 1987
  - Flexible Measurement Rules: submitted to CQS magazine August 1988. Not published.

## **12.6 REPORTS**

The research work was funded by the Science and Engineering Research Council and a requirement of the grant was the submission of detailed reports for adjudication. The first report entitled "Builders' Quantities and Their Use Within Contracting Organizations" was submitted in 1985. This report was adjudged to be satisfactory (vide Appendix A) and further funds were released. The final report entitled "Builders' Quantities for Builders' Management" was submitted in 1988 and was adjudged to be excellent (vide Appendix A). Copies of both reports are held in the work files at Loughborough University.

## **12.7 PROPOSED PUBLICATIONS**

As a result of the preparation of this thesis, further papers are planned and arrangements in hand for their publication. These include:

- 1. Textbooks: Being prepared by Pasquire
  - Preparation and Management of Measured Data for Contracts Without Quantities (for Building Contractors) to be published by Blackwell Scientific Publishing. Outline accepted February 1985.
  - Measurement Rules for Builders' Quantities An Operational Manual: ditto.
- 2. Paper being prepared by Pasquire
  - Measurement of Builders' Quantities for use as a Management Tool, to be submitted to CIOB for publication as an Occasional Paper. Accepted in principle February 1991.

## **12.8 WORK FILES**

The following work files are held within the Department of Civil Engineering at Loughborough University of Technology:

- documents received from contractors during the research;
- copies of papers, articles etc. listed above;
- working notes and early drafts of measurement rules; and
- worked projects including all measured data and drawings.

## **REFERENCES CITED**

- 1. McCaffer, R. Builder's Quantities and Their Use Within Contracting Organizations. Application to SERC, Reference GR/E/78469; 1984.
- 2. Bingham, T. Contracts Heavyweight Associations' Clean Up Job, Building Issue 15, 12th April 1991, p.27.
- 3. McCaffer, R. Builders' Quantities and Their Use Within Contracting Organizations Application to SERC, Reference GR/E/78469; 1984.
- 4. Wolcott, H.F. Writing Up Qualitative Research; Qualitative Research, Qualitative Research Methods Series 10, Sage Publications, 1990, p.10.
- Kirk, J. and Miller, M.L. Reliability and Validity in Qualitative Research, Qualitative Research Methods Series 1, Sage Publications, Fourth Printing, 1988, p.9.
- 6. Ibid Page 17.
- 7. Ibid Page 18.
- 8. Ibid Page 13.
- 9. Standard Method of Measurement for Building Works, 6th Edition, Preface to the 1st Edition, Royal Institution of Chartered Surveyors, 1988, p.10.
- Strotton, C. SMM7 Review, Chartered Quantity Surveyor, Volume 10, No. 8, April 1988, p. 27.
- 11. Ibid.
- 12. Ibid.
- 13. Manual for the British Property Federation System for Design and Construction, 16 December 1983, para. 3.0.7.

- 14. Deny, R. The BPF System How it Works, The Surveying Technician, February/March 1985.
- Report of the Working Party on the BPF Edition of the A.C.A Form of Building Agreement, Royal Institution of Chartered Surveyors, November 1984.
- Tyler, A. and Pasquire, C. Bills of Quantities Are They Needed?, Paper presented at RIBA/CICA Conference, Barbicon Centre, London, January 1987.
- 17. Chartered Institute of Building, Code of Estimating Practice, 5th Edition, October 1983, p.5.
- 18. Ibid.
- 19. Ibid Page 36.
- 20. Ibid Page 37.
- 21. Ibid Page 83.
- 22. Ibid Page 82.
- 23. Skinner, D.W.H. The Contractors' Use of Bills of Quantities, Chartered Institute of Building, Occasional Paper No. 24, 1981, p.3.
- 24. Ibid Page 4.
- 25. Ibid Page 29.
- 26. Ibid Page 32.
- 27. Ibid.
- 28. Strotton, C. SMM7 Review, Chartered Quantity Surveyor, Vol. 10, No. 8, April 1988, p.27.

- 29. McCaffer, R. and Pasquire, C. Flexible Measurement Rules, 1988. Unpublished.
- 30. McCaffer, R. and Pasquire, C. Builders' Quantities for Builders' Management, SERC Report, Loughborough University of Technology, 1988,
- 31. Tyler, A. and Pasquire, C. Bills of Quantities Are They Needed? Building Technology and Management, June/July 1987, p.17.
- 32. Ibid.

٠

- 33. Ibid.
- 34. Chartered Institute of Building, Code of Estimating Practice, 5th Edition, October 1983, pp. 36 & 37.

## **BIBLIOGRAPHY**

- Ashworth, A., Factors Influencing the Cost of Brickwork and Blockwork, Estimating Information Service, Institute of Building; Autumn 1980 No 38.
- 2. Bishop, D., Operational Bills and Cost Communication, Building Research Establishment.
- 3. Braid, R.S., *Importance of Estimating Feedback*, Technical Information Service, CIOB, Autumn 1984 No 39.
- 4. British Property Federation, Manual for the British Property Federation System for Design and Construction, December 1983.
- 5. CIOB, Code of Estimating Practice, 5th Edition 1983.
- 6. Davies, C., The BPF System, Building, 15 June 1984.
- 7. Deny, R., *The BPF System How it Works*, The Surveying Technician, February/March 1985.
- 8. Ferry, D.J. and Brandon, P.S., *Cost Planning of Buildings*, 5th Edition 1984; Collins.
- 9. Ferry, D.J. and Holes, L.G., *Rationalisation of Measurement*, Royal Institution of Chartered Surveyors.
- 10. Forbes, W.S. and Skoyles, E.R., *The Operational Bill*, Building Research Establishment.
- 11. Forbes, W.S. and Skoyles, E.R., A Practical Application of Operational Bills, Building Research Establishment.
- 12. Gilchrist, A. and Gaster, K., Information System Relating to the Construction Industry, Building Research Establishment.

- Hanson, M., How the BPF System Works, Chartered Surveyor Weekly, 15 December 1983.
- International Council for Building Research Studies and Documentation (CIB), Conference Papers from Working Commission W=65.
- International Council for Building Research Studies and Documentation (CIB), Conference Papers from Working Commission W=55.
- 16. Janes, I.L., Crucial Decisions, Leadership in Policymaking and Crisis Management, Free Press, 1989.
- Kirk, J. and Miller, M.L., Reliability and Validity in Qualitative Research, Qualitative Research Methods Series 1, Sage Publications, 4th Printing 1988.
- 18. Knowles, J., A Potshot at the BQ, Chartered Quantity Surveyor, March 1984.
- 19. Lemmasany, J. and Clapp, M.A., *Resource Inputs to New Construction*, Building Research Establishment.
- 20. McCosh, A.M. and Scott-Morton, M.S., *Management Decision Support* Systems, Macmillan, 1978.
- McCaffer, R. and Pasquire, C.L., Interchange and Use of Data by Contractors' Management Functions, International Journal of Construction Management and Technology, Vol. 2, Issue 4, 1987.
- 22. Ministry of Public Works, Code for the Measurement of Building Work in Small Dwelling Houses, HMSO, 1949.
- Powell Smith, V., Radical Reforms, Architects Journal, 21-28 December 1983.
- 24. RICS, Report of the Working Party on the BPF Edition of the ACA Form of Building Agreement, November 1984.

- 25. RICS, Report on Design and Construction, 30 May 1984.
- 26. RICS, Standard Method of Measurement, 6th Edition 1979.
- 27. RICS, Standard Method of Measurement, 7th Edition 1988.
- 28. Simms, J., Positive Action Needed on Bills, Building, 6 January 1984.
- 29. Skinner, D.W.H., *The Contractors' Use of Bills of Quantities*, Chartered Institute of Building, Occasional Paper Nr 24, 1981.
- 30. Skoyles, E.R., Introduction to the Operational Bill, Building Research Establishment.
- 31. Skoyles, E.R., *Examples from Operational Bills*, Building Research Establishment.
- 32. Skoyles, E.R., *Site Accounting for Waste of Materials*, Building Research Establishment.
- 33. Skoyles, E.R. and Hussey, H.J., *Wastage of Materials on Building Sites*, Building Research Establishment.
- 34. Strotton, C., SMM7 Review, Chartered Quantity Surveyor, Vol. 10, Nr 8, April 1988.
- 35. Turner, D., Design and Build Contract Practice, Mcmillan.
- 36. Tyler, A. and Pasquire, C.L., *Bills of Quantities Are they Needed?* Building Technology and Management, June/July 1987.
- 37. Waters, B., The BPF System, Building, 16 December 1983.
- 38. Wessex Database, Building Price Book, 3rd Edition 1986.
- 39. Wolcott, H.F., Writing Up Qualitative Research, Qualitative Research Methods Series 20, Sage Publications 1990.

## APPENDICES

- A SERC APPLICATIONS AND ASSESSMENTS
- **B** CASE STUDIES
- C DELETED
- **D** INTERVIEWS WITH EXPERTS
- E FIELD TRIALS EVALUATION OF TESTED WORK

.

F - DELETED

## APPENDIX A

SERC APPLICATIONS & COMMENTS

## APPENDIX A

## SERC APPLICATIONS & COMMENTS

| Con | tents |  |
|-----|-------|--|

:-

| <b>A.</b> 1 | - | SERC application GR/E/78469    | Page | 1  |
|-------------|---|--------------------------------|------|----|
| A.2         | - | SERC assessment GR/E/78469     | Page | 4  |
| A.3         | - | SERC application GR/D/64223    | Page | 5  |
| A.4         | - | Referree's comments GR/D/64223 | Page | 8  |
| A.5         | - | SERC assessment GR/D/64223     | Page | 10 |

2

#### BUILDERS QUANTITIES AND THEIR USE WITHIN CONTRACTORS ORGANISATIONS

#### A. DESCRIPTION

#### Background

For many decades pre-contract procedures in the United Kingdom Building Industry (and certain ex colonies) have been dictated by the client/ designer/Quantity Surveyor/Contractor relationship enshrined in the various forms of contract and in particular those produced by the Joint Contracts Tribunal,

The pre-contract procedures are in three stages.

1. The client appoints and briefs the designer and the designer designs.

- 2. At some stage of design a Quantity Surveyor receives the designs and converts them into measurements and descriptions which are called the Bills of Quantities using a standard method of measurement which is universally recognised and used throughout the profession.
- 3. Then several contractors are provided with identical Bills of Quantities which they use for preparing a tender in the knowledge that each is doing it on the same basis and each is familiar with the language used. At this stage a Contractor is selected and awarded the contract.

During the contract, the Bills of Quantities are used for the measurement of variations and the preparation of Interim Valuations and the Final Account. Because the Bills do not have to be quantitatively accurate and indeed seldom are (the use of provisional sums being one example) they are of little subsequent use other than as a specification to the contractor while he is carrying out the construction phase.

Because the standard method of measurement on which the Bills are based is unrelated to the more practical requirements of the construction process, such as purchasing, labour procurement, calculation of vastages, planning and bonusing, all of which require a different system of measurement, the Bills of Quantities, even if accurate, cannot be used without considerable additional work and transformation.

The transformation which takes place is significant and can be illustrated as follows:-

#### USE OF BILL

1 / .

#### NECESSARY TRANSFORMATION

Estimating

a) Individual items must be grouped together to form recognisable trades and/or minor operations.

b) 'Minor' items, insignificant in extent or value, are bracketed with major items.

c) 'Minor' items, significant however, in content and value, where included in major descriptions have to be separated so that they can be valued.

d) Work illustrated by drawings and without measurement has to be weasured. Cost Control

Planning

 a) The quantities are transferred into quantities of work, operations, elements or packages against which costs can be measured and compared.

b) Quantity descriptions containing similar materials must be broken down so that the materials can be totalled.

 a) The quantities must be grouped together into recognisable activities which have finite beginning and end events.

b) Where quantities contain operations carried out at different times and by different operatives the descriptions must be divided.

a) Material must be extracted from quantities and transferred into purchasable units having allowed for waste and preferred units (e.g. Bricks in thousands, sand and cement in mortar in tonnes).

The unsuitability of the Bills of Quantities for what might be called 'a contractor's management tool' is not surprising considering that the Industry's Joint Consultative Committee and Joint Contracts Committee in their Forms of Contract, Codes and standard methods imply that the purpose of Bills are to:

- Describe and specify work adequately even though measurement might not be correct.
- 2. Obtain several tenders on a fair and equitable basis.

3. Value variations and interim and final payments of the contract.

The gap between the Bills of Quantities and the requirements of the 'Contractor's Management Tool' is enormous. The gap is only bridged by the compensating work of the various sections in the Contractor's organisation Often the bridging is not attempted and the 'Contractor's Management Tool' is either a fresh document sometimes prepared separately by each section or, because of the resources involved, not even attempted.

Various unsuccessful attempts have been made by BRE and other bodies to produce Bill formats which are more useful to contractors. These have been elemental bills and operational bills, but have not achieved their sims becau they also attempted to satisfy the conflicting demands of a tender document.

Because of growing pressures by the Client, Contractor and sometimes, designer, the traditional four-cornered relationship which has been described earlier, is being increasingly eroded. The client is impatient of the time lag between brief and contract start and, often himself a manufacturer, does not understand the concept of design being spart from production and the wrangles that ensue. The contractor, an entrepreneur and often trained manager, sees a market opportunity in the impatience of the Client and embraces the design function. Many designers who have not seen themselves as managers, anyhow, are happy to join any permutation or combination that provides them with work and allows them to get on with their perceived 'real job' of design.

Purchasing

Even if this radical restructuring is not undertaken by the client he is increasingly on the grounds of economy omitting the Quantity Surveyor from the process and providing the contractor with drawings and a specification only thus saving himself the surveyor's fees. This practice has even spread to the PSA, who as a public authority are publicly accountable and therefore can be assumed to have justified the practice.

As the industry changes, spurred by a reduced market, many contractors have undertaken diversification and through vertical integration become their own client and in the role of Developer often with an in-house design service.

In these situations there is one common feature. The Contractor is no longer restrained by the traditional Bills of Quantities. Measure he must, but he is free to measure in any way best suited to his own aspirations and he can make his own choice of measurement method.

Ironically, the smaller Contractor without his own in-house measurer, turns often to the independent quantity surveyor who, without guidance, produces Bills of Quantities along traditional lines that are of little or no further use to the contractor.

In the majority of cases, however, the contractor employs his own in-house measurer who, because of the pressures of time and cost devises his own method of measurement; a short-hand which is called 'Builders Quantities'. Builders Quantities are a hybrid of a condensed version of traditional Bills with shorthand descriptions and often measured on the basis of practical operational units which will be of later use if the contract is secured. There is considerable diversity in the form and detail between firms and even within a firm.

Because of the evolution and change brought about by new requirements and markets, particularly overseas, where there is also an increasing tendency to move towards the American system builders are developing and using 'Builders Quantities' because it is of value to them to do so. It is likely that Builders Quantities will be the tool of the future and it is time that they were taken seriously rather than let them develop in an ad-hoc fashion.

'Builders Quantities' can be influenced and rethought out before they become an entrenched part of the system. They can be examined separately in their own right free from the inhibitions imposed by Standard Methods or Joint Committees striving for compromise between vested interests. 'Builders Quantities' can be for builders.

This is not to challenge the position or role of standard methods of measurement which will and possibly should remain to perform their function in traditionally administered contracts. The comments apply to the use of measured data by contractors.

It is known that some contractors have devised their own methods and procedures. Some are more advanced in some features than others. These are not widely known. The smaller contractor, representing the largest number of companies in the Industry, is lucky if he has heard of the developments or has thought of his ultimate requirements or has the resources to do it on his own. This research work would enable these companies to obtain better practices.

There is need therefore to establish a definition of the preferred format for the 'BUILDERS QUANTITIES', for the main sections of work.

The hypothesis is that in non-traditional forms of contract where the contractor measures the quantity data the measured quantities can describe and specify work accurately for estimation purposes while at the same time providing an operational management document that forms the basis of the requirements of the other management functions of purchasing, costing and planning and that the definition of the quantities to be measured can be determined from these management functions. Allied to this is the hypothesis that if such BUILDERS QUANTITIES were defined, standardised and well published they would be understood and used by many building contractors, improving the management of these companies.

AIMS

÷.

()

- (a) To research within Contractor Companies and to define the use to which measured quantity data is put in the management functions of the estimating, purchasing, cost control and planning.
- (b) To determine what quantity data should be measured for the benefit of the management functions.
- (c) To field test the determined measurement rules from (b) with up to three specification and drawing contracts.
- (d) To publish the findings, probably via the Chartered Institute of Building.

#### B. PROGRAMME\_OF WORK

This is a co-operative proposal made jointly with Wm. Walkerdine Limited, who will provide the operating estimators, buyers, surveyors and planners to aid the pursuit of objectives (a), (b) and (c).

This research application will provide a research assistant. The Estimating Practice Committee of the Chartered Institute of Builders has already set up a working party under the Chairmanship of the applicant to investigate these and related topics, and this working party and its parent committee will be supportive in this work, in providing access to other companies for the purposes of testing findings and participating in field trials.

The approach will be to use the research assistant:

- (a) to investigate the use each of the management functions makes of measured quantity data using the access to the staff of Wm. Walkerdine Limited;
- (b) to check the findings of (a) with other companies, using the CIOB contacts;
- (c) to determine what quantities should be measured to suit each of the management functions for each of the main sections;
- (d) to field test the determined rules using up to three specification and drawings contracts; and
- (e) to publish the results.

The programme of work is as below.



#### C. PREVIOUS WORK

Various attempts have been made at revising standard methods of measurement. Little published work exists on use of measured quantities within contractors organisations. The Estimating Practice Committee of the CIOB have established a working party to examine the use of estimators data within the other management functions; this work is related to this proposal. The applicant is chairman of the working party.

#### D. RESEARCH EXPERIENCE

The applicant has previously held five SERC grants, five BRE contracts, two NRDC contracts and has undertaken work for industry. The collaborator, Mr. John Walkerdine is Chairman and Managing Director of Wm. Walkerdine Limited and Past President of the Chartered Institute of Building. C.V.'s are attached.

#### E. REQUIREMENTS

#### STAFF

к.

Research assistant, a graduate with a background in building management, or equivalent. An age of 30 is likely for the necessary experience. Point 6 on RAIA, (i.e. 19,425) is suggested. Research assistant for 18 months

TRAVEL

Travel from University to Wm. Walkerdines 200 journeys at £6.00 each = £1200 18 other journeys to other companies at £30.00 each = 540

Total Travel

1,740

£18.150

INPUT by Wm. Walkerdine Limited

Wm. Walkerdine will provide the following staff

| Estimator     | 3 man months  |
|---------------|---------------|
| Planner       | 2 man months  |
| Purchaser     | 2 man months  |
| Site surveyor | 2 man months  |
| Cost clerk    | 2 man months  |
| Bonus clerk   | 1 man month   |
| Total         | 12 man months |

The average cost of each of these staff is taken as £10,000, plus 25% for overheads, giving £12,500 p.a.

Total staff input by Wm. Walkerdine Ltd. = £12,500

In addition staff travel by Wm. Walkerdine staff to University will be provided Estimated at f1,500

Total input by Wm. Walkerdine Ltd. = E14,000

#### F. APPLICATION

۰.

Measurement Rules for Builders Quantities which are useful in other management functions would be widely used by many building contractors engaged in:

1) Design construct work; and

2) Specification and Drawing Contracts.

It is expected that the proposed work will make a major contribution to improving the flow of data within construction companies. There is evidence that in companies each function is comparimentalised and the transfer of data from one function to another is restricted which leads to duplicated effort. The development of measured quantity data which is used in estimating and subsequent management function will achieve an improved flow of data within these functions. The measurement rules devised should then influence the development of automatic quantity data generators that will be forthcoming from the Computer Aided Design and Draughting systems of the future. This work is seen as an essential prerequisite to such future developments although its immediate use in current manual practice is more immediately achievable.

#### G. EXPLOITATION

Wm. Walkerdine Ltd. have agreed to the full and uncensored publication of any results from this work. One possible vehicle for such publication would be the CIOB.

## Science and Engineering Research Council

Polaris House North Star Avenue Swindon SN2 1E7

Telex 449466 Telephone O793 26222 ext

Dr R McCaffer Dept of Civil Engineering Loughborough University of Tech Leicestershire LE11 3TU GR/E/78469 Date 2 April 1987

Dear Dr McCaffer

## BUILDERS QUANTITIES AND THE IR USE WITHIN CONTRACTORS' ORGANISATIONS

I am pleased to inform you that the Final Report on the work supported by the above grant has been considered by the Building Subcommittee and was found to be satisfactory.

Yours sincerely

100

C L Janes Environment Committee Secretariat

cc The Registrar

Project Title : Builders Quantities and Builders Management - Field Trials.

(a) INTRODUCTION AND PURPOSE

This proposal is concerned with the generation and use of measured data within contracting organisations. The work is particularly directed at non-traditional forms of contract where the contractor is responsible for measuring the quantities.

It was argued in support of a previous research grant awarded April 1984, that it should be possible to define a set of builders quantities that could accurately describe the work for estimating purposes, whilst at the same time provide an operational management document for use by the other management functions. These functions being purchasing, costing, planning, measurement and valuations, and site management. It was further agreed in the previous application that these builders quantities could be derived from the observations made of the use of measured data by the various management functions within a contracting organisation.

The grant (No GR/C/7846.9) awarded was £21,491 for eighteen months. The results of this work are given in outline in Appendix 1. and described in more detail in a research report submitted separately.

Broadly the achievements were :-

(i) Case studies which defined the management functions within construction companies and the tasks performed using measured data.

(ii) The identification of the flow of data within and between these functions and the amount of re-working of measured data by each function.

(iii) Derived from (i)  $\leq$  (ii), a set of builders quantities was defined which attempt to minimise the re-working of data by each function.

The aims of this current proposal are :-

(1) To field test the use of the Builders Quantities defined in the previous work in at least two, and preferably three, projects of reasonable size within the functions of :-

> Estimating; Purchasing; Planning; Site Management; and Surveying.

(2) On the basis of the use of Builders Quantities in the trial projects, to define the interface and data transfer between

the function groups that are most effective. (Note in the existing project the existing interface was observed).

- (3) To refine and extend these Builders Quantities based on the results of the field tests.
- (4) To document the use of these Builders Quantities in the trial projects so that they may be used as an effective operational management document by the various functions groups.

(5) To publish the work.

The aims can therefore be seen as building on the existing research work and scaling up the results to a level on which practicality and advantages can be shown.

The current testing of the builders quantities is limited to one project. This is only sufficient to test the principles of using the defined set of Builders Quantities, but not the practicalities nor to define the data interfaces between the function groups.

The proposed project will therefore, examine the practical applications of the earlier work and continue its development into a contractors management tool. It is hoped that this development will pre-empt the ad-hoc use of measured data for design-construct contracts by the industry. This is especially important for the smaller building company which does not have the resources to employ in-house design teams and are expected to procure an increasing number of contracts on a designconstruct or specification and drawing basis.

The results of this proposed project will provide the definition of a set of proven Builders Quantities and a description of their actual use so that the interface between the various management functions is efficient, minimising the amount of re-working of such data. It will be concentrated within the contractors organisations and linked to non-BQ type contracts, but if shown to be successful may influence BQ-type contract management also.

The existing co-operating contractors, Wm Walkerdine and Y.J Lovell Ltd, are keen to continue the work and have agreed to provide suitable contracts for field trials.

(b) BACKGROUND

(i) Previous Work

This current proposal builds on the work of an existing grant (No GR/C/7846.9) and the report of the work to date is summarised in section (a) above and in appendix 1.

Two other items of work that are relevant to this project are :-

(a) The Chartered Institute of Builders have a working

party studying the "Post-Tender Use of Estimators Data". The applicant is a member of this working party.

(b) A current SERC funded project on the Use of Computers in Contracts Without Bills of Quantities is relevant. This project does not attempt to define or generate measured quantities but merely to manipulate the data already available from the contractor.

#### (ii) Research Experience

The applicants outline C.V is attached.

The research assistant named in the application has been employed on the existing grant from the beginning. A C.V is attached.

#### (C) PROGRAMME OF WORK

The work required to satisfy the aims above is :-



The methodology adopted will be to work in parallel with the estimators, purchasers, planners etc. as work is taking place. When a contractor is invited to tender for a contract without a bill of quantities a decision is required on what data should be measured in order to produce the estimate. The co-operating contractors have agreed part of the research project to measure according to the Builders Quantities rules defined in the previous research project. The research assistants tasks at this point will be to aid the estimators by: assisting in data preparation; and explanation of the Builders Quantities; adapting the rules to suit the project and construction method chosen. On a successful tender the research assistant will move to the other management functions of planning, purchasing, costing etc. and render the same service of assistance, explanation and adaption. On final account all the observations and comments of all management functions can be examined against the original set of Builders Quantities and these can be redefined as necessary.

This then provides a comparison with the existing case studies. Thus the current proposals can be seen as using a comparative case study approach. The previous work having provided the 'control' the proposed work producing the case studies using the newly defined Builders Quantities. The new case studies will inevitably lead to refinement of the defined measurement rules. The intended results are a set of flexible rules which makes the flow of data within a contractors organisation as efficient companies. It is hoped that the case studies will provide the hard evidence of advantages, which when published will convince other contractors.

#### (d) REQUIREMENTS

STAFF

Research Assistant, Ms. C. Pasquire, A.R.C.I.S., Aged: 29 Current Salary: £10,330 existing SERC funded appointment 18 months. Point 7 on R.A.I.A. Proposed duration of appointment 24 months. Total staff cost £26,679.

#### INPUT BY OTHERS

The support and input of industry is very necessary and Wm. Walkerdine Ltd. and Y.J. Lovell Ltd. have agreed to provide this. It is therefore appropriate to place some value on their contribution in kind.

Input by Wm. Walkerdine Ltd. and Y.J. Lovell Ltd.

| Estimators | 5 | man | months |
|------------|---|-----|--------|
| Planners   | 3 |     | -      |
| Purchasers | 3 |     | H      |

| Site Surveyors | 4  | - |
|----------------|----|---|
| Cost Clerks    | 2  |   |
| Bonus Clerks   | 1  |   |
| Total          | 18 |   |

If the average cost of these staff is taken at £12,000 with 25% added for overheads giving a total of £22,500 the above contribution is costed at £22,500.

Letters of support are attached.

#### (e) APPLICATION

Measurement rules for Builders Quantities which are proven to be useful in other management functions and minimises the amount of re-working of data at the interface between the function groups would be welcomed by the industry particularly those employed in Design Construct work and Specification and Drawings contracts.

The existing work has proved valuable in identifying the tasks, the function groups, the existing interfaces and the flow of Data. The first attempt at defining a set of Builders Quantities holds the promise of achieving improved data flow within the contractors organisation and a reduction in duplicated effort. The current proposal should follow this through to a proven set of Builders Quantities and an accompanying operational document. It would be up to individual contractors to implement the use of these Builders Quantities. They do not require the agreement of great institutions or collaboration between parties with different vested interests. This is seen as a strength in the hope of moving forward. The individual contractors will only adopt the approach if there is sufficient hard evidence of real advantage and clear direction how to implement and use the 'Builders Quantities'. It is hoped that this current proposal will provide these.

Looking towards the use of high technology there already exists computer aided taking-off systems which link the taking-off directly to estimators data bases. The measurement rules proposed should have great influence on these systems as well as on the emerging automatic quantity generators and links with computer aided design and draughting.

#### (f) EXPLOITATION

Papers on the existing case studies recording data flows are being prepared and it is likely that the full results will be published in book form. It is considered that the widest publications of this work amongst contractors by publications and seminars is likely to be the best means of making the industry aware of this work.

5

#### APPENDIX 1

Builders Quantities and Builders Management

Summary Report

In April 1984 SERC's SPP in Construction Management awarded a grant (No. GR/C/7846.9) for a project entitled "Builders Quantities and Their Use Within Contractor's Organisations", the value of the grant was £21,491 for a period of eighteen months. The work to be confined to contracts without bills of quantities, namely design build and specification and drawing contracts.

The work that has taken place and the main findings are contained in a research report submitted separately and are summarised here.

The work undertaken comprised the following :

(a) Case studies to :

1

- (i) identify the tasks relating to the use of measured data performed within the company;
- (ii) identify the function groups undertaking these tasks;
- (iii) identify the information used in particular the measured data;
- (iv) identify the flow of measured data within and between the function groups; and
- (v) to provide a framework within which to define the Builders Quantities.
- (b) The definition of a set of "Builders Quantities" intended to minimise the amount of re-working of data by each management function;
- (c) The testing of these "Builders Quantities" with one project, value £250,000.

The significant conclusions drawn from these case studies and the accompanying literature review were :

- Previous literature deals mainly with attempts at revising contract documentation and not specifically with the internal use of data within contractors organisations. This is also true of the major attempts at devising coding systems.
- \* The tasks related to data use within a contractors organisation are clearly identifiable and consistent between companies but the allocation of these tasks between the function groups (i.e. estimators, planners, purchasers etc.) undertaking them is not always the same.
- The most influential documents on the manner of tackling these tasks relating to data use are the contract documents and these are prepared outwith the contracting organisation.

6

Of the various forms of contract the Bill of Quantities type contract is the most common and the effect of this form of contract documentation goes beyond its own employment and is a major influence on execution of the tasks of non-B.Q. contracts such as design-build or specification and drawing contracts. The evidence is that even in these non-B.Q. contracts the contractors organisation re-creates a bill of quantities, usually using the standard method of measurement and frequently employing outside quantity surveyors to produce it.

- \* All forms of contract in use deal with descriptions of the final work and no information is supplied in the contract documentation with regard to resources required in the construction.
- \* All main function groups (estimators, planners, purchasers, site management, surveyors and higher management) deal with measured data and the measured data covers the seven trades of excavation, concrete work, brickwork, woodwork, drainage, external works, and alterations, virtually all other work is sub-contracted and the sub-contractor deals with the measured data.
- \* A main flow of data from estimator and planner through the purchaser, site management and the surveyor was identified together with other secondary flows between certain of the function groups. The incidence of re-working of measured data transfered between function groups was identified and is described in the research report.
- \* The first group to be involved with measured data is the estimators and a method of compiling measured data for this function in non-B.Q. type contracts that could be used by the purchasers and site management seemed attractive. However, for the estimator to undertake the task of providing a complete set of ordering schedules, for example, was shown to be impractical. Therefore, the aim was revised to defining a set of measurable builders quantitles for use by the estimators which could be used by the other function groups who could abstract their requirements without re-working the same information.

()

\* Drawing on the current use each function group made of measured data the first attempt at a set of Builders Quantities was drawn up.

These are described in the research report.

\* This set of builders quantities was tested against a small project comprising an extension to an existing building with a basement valued at circa £250,000.

The development of the builders quantities is limited and unrefined and the testing is small scale. This has however shown to work in principle and therefore this second application is brought forward to extend the testing into more sizeable projects and to refine the definition of the Builders Quantities. This is considered necessary to reach a level of appreciation by industry.

R

. منبعا

## **Department of Construction Management**

University of Reading

Professor John Bennett 11 October 1985

ുറാ

Dr R Flanagan Dept of Construction Management University of Reading

#### Dear Roger

٠,.

1

JB/SR

#### SERC Grant Application GR/D/64223

In addition to the formal application, I have been provided with the detailed rules for Builders Quantities for Builders Management produced by the applicant under SERC grant GR/C/7866.9. In my view the applicant proposes to carry out straight-forward development work in two companies. This is work which, for the sake of their own efficiency, the companies would need to carry out if the incidence of projects without bills of quantities increases significantly. This point is reinforced by the detailed rules which are totally project specific and therefore of no general value. This is not entirely surprising since they have been developed for one project.

Applying the rules to three more projects, which is the proposal in the present application, will make them somewhat less specific. It will also make them more complicated as more different materials and forms of construction are covered.

This of course is why the SMM itself is fairly complicated. It must deal with all building projects and so must provide rules for every feature which may be cost significant on any project.

I cannot find practical benefits in the work except that is to the two companies involved. For there to be general benefit, the work needs to be enlightened with a theoretical framework which explains why cartain quantities are worth calculating and others not. Then the field trials would constitute a test of that theory and there would be the chance of new knowledge being gained. As the proposals stand the results will merely be one arbitary selection of quantities peculiar to two or three projects but not necessarily of any general value. Certainly the proposal contains no hint of a theoretical basis for the work.

I would not recommence making a grant and my answers to your specific questions are:-

 There will be no general benefit. The benefit to the firms involved is difficult to calculate, but may well at least equal the cost of the proposed work.

continued...

University of Reading Whiteknigh Reading RCs 280 Telephone 0734 876123  The techniques are arbitary since the results are project specific. To be of value they need theory and properly 'designed'tests.

 Seeing the current detailed rules provided the further information meeded.

-2-

Any work on measurement inevitably duplicates to some extent the work of the SNM Development Unit. Their work includes field trials which involve builders. Although the declared aims of SNMT are different from the rules proposed by the applicant, in practice SNM is used albeit in a modified form for builders quantities. This has the key advantage of not imposing two different standards on builders. In my view if the applicant attempted to produce non-project specific rules, he would be driven to something like SNMT. To that extent there is duplication.

If the application is accepted, then the level of resources proposed is sensible.

John Bonnett

John Bennett

7

ſ

Yours sincerely

4.

5.

## **Limited** Building & Civil Engineering Contractors

Dr Roger Flanagan Department of Construction Management University of Reading Whiteknights Reading RG6 2BU

Highway Works Maldenhead SL5 48W Telephone Maldenhead (0528) 33144 Telex 545925 Fax No 0528 782580

your ref our ref RF/HRT/cd AJB/NV date 7th October 1985

-

1

ы

.

5

Ũ

3

Dear Roger

Grant Application: Builder's quantities and builder's management - field trials

Thank you for your letter dated 26th September and the enclosures relating to the Grant Application. I have read them with a great deal of interest as I was extremely pleased to see that at last some work was being done in this particular direction. It has always been a source of concern to me that so much time and effort goes into the production of standard Bills of Quantities which then serve only as a document on which to agree and adjust a price. I have always thought that what was really needed was a form of quantities which could then be used through the building process of estimating, ordering, costing, etc.

- To answer the specific points that you raise in your letter, I reply as follows:
- 1. It is difficult to make an estimate of the benefits that would accrue to industry except to say that they would be considerable. There has been an increasing tendency towards contractors tendering for work on the basis of drawings and specifications and they are, therefore, obliged to prepare their own Bills of Quantities.
  - I can see no disadvantage accruing with the proposed research technique as most certainly field testing with contractors must be the best route.
  - I can think of no further information that I would require.

/continued ...

Directors Quentin Jones FRICS AJ Barry PPCIOM Managing AW King FRICS FCIOB PE Stevens MCIOB AW Newmen FRICS CG Dyke FLAS CF Murphy MCIOB G Roberts ACMA Secretary Registered in England No 755000

# JMJ

4. As you probably know I do keep reasonably in touch with research and development matters and I am not aware of the possibility of any duplication.

- 2 -

I am sorry that I have nothing else worthwhile to contribute at this point but I would most certainly be happy to be of any further practical assistance that you may require if you wish to extend your field trials.

I would be grateful to be kept informed of the progress made.

Yours sincerely

PP A J Barry

## Science and Engineering Research Council

Programmes Directorate

Polaris House, North Star Avenue, Swindon SN2 1ET

Telephone (0793) 411000 Fax (0793) 411400 GTN 1434 Telex 449466

Direct line Direct Fax line 411060

Professor R McCaffer Department of Civil Engineering Loughborough University Ashby Road Loughborough Leics LE11 3TU

(iii)

Ref No: GR/D/64223 22 May 1990

Dear Professor McCaffer

ASSESSMENT OF FINAL REPORT: BUILDERS' QUANTITIES AND BUILDERS' MANAGEMENT ~ FIELD TRIALS

Thank you for completing and returning the final report on the above mentioned research grant.

The final report has been assessed and assigned the following markings, as indicated by the ticks below:



Your work has therefore been placed in Category Number 1. For an explanation of Our assessment system see paragraph 8.5.3 of the "SERC Research Grants" booklet (September 1989).

It is hoped that the comments attached, which were provided by an assessor, will prove useful.

We would also appreicate any photographs you could provide related to this research programme.

Yours sincerely

James Fraser Environment Committee Secretariat

cc The Registrar

#### GR/D/64223

Έ,

The report itself is an excellent start. However, it will be pursued vigorously with a further study (field trials) <u>here in UK</u> to prove it. It must also be pursued in more publications and with Employer-type bodies (BPF).

APPENDIX B

## CASE STUDIES

## INDEX

& ODIEOTIVES

ът

TTD /

| INTRODUCTION & OBJECTIVES          | -              | rage 1  |
|------------------------------------|----------------|---------|
| METHODOLOGY                        | · <del>-</del> | Page 1  |
| CASE STUDY A<br>LOVELL MIDLAND LTD | -              | Page 3  |
| CASE STUDY B<br>LOVELL FARROW LTD  | -              | Page 15 |
|                                    |                |         |

CASE STUDY C Wm WALKERDINE LTD Page 25

## CASE STUDIES

## INTRODUCTION

Case studies were undertaken within three contracting organisations. These studies took the form of several visits to the various departments at the company head offices. During the visits a variety of personnel were interviewed and the departmental procedures observed.

## **OBJECTIVES**

The objectives of the case studies were as follows:

- to identify the tasks performed during the pre- and post-contract management of construction projects;
- to relate the tasks to a management function, eg estimating, planning, etc.;
- to define the data used for the management of construction projects and particularly measured quantity data, ie that relating directly to the procurement and management of the resources of labour, plant and materials for the construction works;
- to identify the use to which the measured quantity data re put;
- to identify which data are transformed, reworked, ignored and/or compiled afresh;
- to relate the data manipulation to the management tasks to identify tasks where the presentation format of the data is critical to the use.

The findings of the case studies were used to define a framework for data presentation and the first draft of the measurement rules.

## METHODOLOGY

In each of the three cases, the research commenced in the Estimating Department as this was where proposed projects were first received by the company. It was also likely that the Estimating Department would be the only department to deal with the proposed project, as only one in ten or so tenders were successful (see individual case study notes for more information on successful tenders).

The first step in the case study research was to identify the size and type of tenders prepared along with the client type and tender documents used. The reason for this was to identify any correlations between these and the subsequent use of data during the management tasks. This information was common to all the management personnel within the company and could be identified as company specific.

This was followed by informal interviews with the various management personnel combined with observations of the tasks performed, identifying the procedures adopted and discussing these with the personnel involved.

During this discussions and observations the use, manipulation and flow of data was identified.

### **CASE STUDIES**

## **COMPANY A : LOVELL MIDLAND LTD**

## GENERALLY

Lovell Midland Ltd was part of the large national group of construction companies, Y J Lovell. Lovell Midland Ltd was responsible for construction works in an area covering the Midlands, the more northern of the Home Counties and parts of Wales.

Lovell Midland Ltd was based in Aylesbury, Buckinghamshire but had smaller offices on the various construction sites spread throughout it's area. A total of six visits were made to the Aylesbury office during the months of October and November 1984.

## **PROJECTS UNDERTAKEN**

Most of Lovell Midland Ltd's work comprised large "one-off" projects often for central or local government. Other clients included banks, insurance companies, large retail chains and commercial and industrial developers. Some housing projects were undertaken but not on a speculative basis. The company had been involved with serial tenders and system building in the past, but none of these types of contract had been received for some time previous to this research. The documents received for tender purposed comprised of specification and drawings, bills of quantities, or design brief with a JCT OR GC Wks standard form of contract.

## THE ESTIMATOR

The Estimating Department at Lovell Midland Ltd comprised seven staff employed for pricing tenders, one chief estimator, four senior estimators and two trainees. The chief estimator, Mr Graham Hall, provided the bulk of the information collected with reference to the senior estimators for particular project examples.

The tender enquiry was received by the estimator in the first instance. If the tender was in the form of a specification or design brief, the estimator immediately referred it to a private practice Quantity Surveyor who measured the job and submitted Bills of Quantities to the estimator. The quantities were measured out-house for two reasons. Firstly, estimators saw their main task as pricing quantities, not

3

measuring them, and did not consider themselves trained to measure. Secondly, there was often not time for the estimators to measure quantities due to the number of tenders being priced at any one time.

The private practice Quantity Surveyors prepared quantities without consulting the estimator, however feedback about the estimators' requirements for pricing quantities was given retrospectively. From this feedback, the Quantity Surveyors were able to adjust their methods of measurement over a period of time until the estimator was happy with the Bill of Quantities presentation. However, no examples of this Bills of Quantities presentation were made available.

It was generally felt by the estimators in this office that a tender enquiry using Bills of Quantities was preferred to any other form. This was because this form eliminates any pricing risk contained in the design brief or specification. One senior estimator (Mr Alan Jarvis) in particular felt that Bills of Quantities were the best basis for a tender because all tenderers were pricing the same documentation and "the lowest tenderer is not likely to be the one making the biggest mistake". Generally speaking, the estimators preferred pricing quantities measured in accordance with the RICS Standard Method of Measurement (SMM) because they understood what had been measured and what was "deemed to be included" in the various measured items. If they were not sure, they could look the item up in the SMM.

## TRADES USING MEASURED QUANTITY DATA

It was ascertained that the main task of the estimator was to price quantities. To do this the estimator first split the quantity items into those which were the subject of sub-contracts, and consequently lump sum quotes from other contractors, and those which were undertaken on site by Lovell employees. These were split by trade into the following groups:

## **Priced by Estimator**

- i) Excavation
- ii) Concrete
- iii) Brickwork
- iv) Carpentry
- v) Joinery fittings
- vi) Drainage
- vii) Externals

## Sub-contractor quotes

- i) Roofing
- ii) Plumbing
- iii) Finishes]
- iv) Tarmac
- v) Special fittings etc.
- vi) M&E services (if not nominated)

Quantities for sub-contract quotations were sent out with enquiries, usually in the form of a trade section from the B/Q. It was found that quotes were not usually returned if quantities were not included with the enquiry.

The rates for measured items priced by the estimator were built up from the net quantities of materials in the Bill of Quantities, and labour rates charged at current company standard rates. The amount of labour required was built up each time according to the job to be undertaken. A wastage factor was added to the net rates in the form of a percentage allowance. This was not an exact calculation as wastage could not be quantified on a particular contract until the work was complete. Therefore, a percentage based on a standard office constant was used; this could be amended by the estimator if he felt it necessary. There did not appear to be any feedback from completed projects on the actual amounts of wastage incurred.

A major section of any tender priced was the preliminaries. In this section, the items related to the conditions of contract, the location of the site temporary works and any special conditions relating to the contractors method of working. These items were often priced with the aid of the site agent who would probably be in charge of the project if the tender was successful.

When all the Bills of Quantities items had been priced in this manner, the costs were totalled and considered as a whole with regard to the amount of overheads and profit to be added to these costs. This figure (called the margin) was very much based on experience and an awareness of the market conditions. The margin was added in the form of a percentage or a lump sum which may have been expressed as a percentage at a later date. This figure then became the target against which the profitability of the job was measured as it progressed.

## **PRICING QUANTITIES**

Measured quantity items were priced in one of two ways:

 commonly occurring items such as concrete, hardcore, common brickwork were used frequently in the estimating office and company standard rates were held for these items. These rates were updated regularly as material and labour prices changed;

5

- ii) other items were broken down into the material and labour content and each of these priced separately. Again, some items were used frequently and material rates held by the estimating department, eg drainage goods. In this example, the labour rate was assessed separately from the material cost as it varied with the depth of the trench;
- iii) unusual items were priced as in ii) above but the material cost was assessed after enquiries were made to manufacturers.

Prices for sub-contract work were obtained by sending a tender form and copies of the relevant drawings and quantities to a sub-contractor who had indicted his willingness to quote in an earlier telephone call made by the estimator. The estimator may telephone several sub-contractors asking for a guide price before he decides which to send a tender enquiry to. Usually only one tender enquiry was sent at this stage. This enquiry later became a target price for the purchasing department.

## INFORMATION

Information received and generated by the Estimating Department of Lovell Midland Ltd:

| Received - the tender documents | - | drawings                      |
|---------------------------------|---|-------------------------------|
|                                 | • | BQ/specification/design brief |
|                                 | - | quantities measured (by QS)   |
| Generated - priced quantities   | - | materials cost                |
| (estimate)                      | - | labour cost                   |
|                                 | - | unit rates                    |
|                                 | - | wastage assessment            |
|                                 | - | sub-contract prices           |
|                                 | - | preliminary prices            |
|                                 | - | margin                        |

## **THE PURCHASER**

## **GENERALLY**

The Purchasing or Buying Department of Lovell Midland Ltd were concerned only with the materials to be used incorporated into the Works. These materials included those for use by labour only sub-contractors, but not those incorporated as part of a materials and labour sub-contract. The latter were dealt with by the site agent and surveyor. There were two purchasers employed by Lovell Midland Ltd, Mr Richard Ellis and Mr Peter Jones, both of whom contributed to the research.

## **PURCHASING SCHEDULES**

The first task of the purchasing department was identified as the isolation of the material content of the Works from the estimate. This was done by the use of schedules.

The schedule further separated the materials into four categories.

i) Bulk items - these were items which were used in large quantities throughout most of the contract period and were commonly used on most types of contract, eg cement, hardcore, common bricks, sand, etc. Orders were placed with suppliers for these items for the total quantities given in the measured quantity documents (BQ or estimate). These materials were then called for by the site agent, as and when needed on site, directly from the supplier. The orders placed with suppliers for these materials were called "covering orders". This means that the quantities ordered were approximate and were firmed up as the work proceeded. This meant that any discrepancy between the BQ quantities and the actual quantities used on site did not cause a problem because the orders given initially were for a flexible or approximate quantity. This was really only possible with large quantity orders. Lovell Midland Ltd tended to have several regular suppliers for these types of materials and used them constantly, so any excess from one contract could pass over to the next on a rolling basis and vice versa.

ii) Materials which were used in large quantities but for shorter more precise periods in the programme, eg drainage goods, facing bricks, reinforcement, etc. were ordered in the same way as bulk items but consideration was given to delivery periods. Consideration would also be given to the possible use of alternative suppliers or manufacturers if delivery periods

7
were too long or if the purchaser thought he could buy the same materials at a more favourable price. Again the measured quantities submitted to the purchaser by the estimator form the basis for the quantity of materials ordered. The purchaser did not measure or re-measure any quantities.

- iii) Standard materials such as doors, windows, lintels, etc. were usually measured as units. This meant that the wastage factor may be higher for this type of material than for the bulk items. Consequently, more care was taken when ordering these materials and the quantities were measured by the site agent and submitted to the purchasing department for ordering. These materials were measured by the site agent after the work had started on site but in time to meet any delivery periods specified by the suppliers. This meant that delivery dates were specified by the purchaser when he placed the order, rather than the site agent calling for part delivery of a bulk item order when he needed it on site.
- iv) Special and one-off items were ordered from more accurate quantities, again prepared by the site agent. The nature of this type of material could cause problems with delivery dates so these materials were split out from the BQ or estimate first, and delivery dates given in line with the programme for the Works. These delivery dates were decided upon with the aid of the planning/programming department as well as the site agent, but the biggest factor was the purchaser's own experience with suppliers and manufacturers delivery periods.

The labour portion o the Works was passed on to the surveyor and site agent who controlled the use and cost of the labour.

# **PLACING ORDERS**

The purchasing department of Lovell Midland Ltd was responsible for the placing of orders with suppliers who could provide the most advantageous prices. The quantities for these orders were calculated by other parties within the company. The purchaser used his knowledge of the market to decide whether to obtain alternative quotes, eg if the supplier or sub-contractor used by the estimator to prepare his tender had been unsatisfactory in the past or if the purchaser knew of a cheaper suitable supplier. It was interesting to note that this Company sublet all its joinery\_works to a subsidiary company who scheduled out the required quantities from the drawings then cut and supplied the timber for the whole contract.

# **INFORMATION**

Information received and generated by the Purchasing Department of Lovell Midland Ltd:

| Received  | - | the tender documents                         | -                     | drawings<br>BQ/specification/design brief<br>quantities measured (by QS)                                                 |
|-----------|---|----------------------------------------------|-----------------------|--------------------------------------------------------------------------------------------------------------------------|
|           | - | priced quantities<br>(estimate)              | -<br>-<br>-<br>-<br>- | materials cost<br>labour cost<br>unit rates<br>wastage assessment<br>sub-contract quotes<br>preliminary prices<br>margin |
| Generated | - | materials schedule<br>alternative quotations | -<br>-<br>-           | bulk items<br>other large quantity items<br>standard items<br>specials / one-offs                                        |

- delivery dates

# THE SURVEYOR

## **GENERALLY**

The Surveying Department of Lovell Midland Ltd comprised one chief surveyor, two senior surveyors and two trainees. The chief surveyor, Mr John Bates, provided the main research data with reference to the senior surveyors, Mr Simon Blackburn and Mr Dean Bennett, for specific project examples.

The surveyors were responsible for monitoring the performance and profitability of the project. The surveying department also defined the target labour costs and controlled the cash flow throughout the contract period. These were achieved by:

- assessing the performance and profitability by comparing actual cost with those allowed by the estimator. This involved regular monitoring of labour sheets and materials invoices and comparison of these with the BQ or tendered rates. Cash flow was monitored at the same time by comparing these items with the monthly valuation figures paid to the contractor by the client.
- ii) target costs were drawn up for the site manager, enabling him to assess the manhours allowed for in the tender for a particular item of the works. The surveyor had therefore, to break down the estimate into sections that related to the on-site work and the programme. These targets were expressed in terms of manhours allocated and maximum hourly rates to be paid, along with the total amounts of money available for each section of the works to be allocated by the site manager.
- iii) negotiations took place with the Client's representative over the preparation of interim valuations, measurement and valuation of variations, remeasurement of work if necessary and the preparation of the final account.
- iv) the progress of the contract on site was monitored and any resulting claims for loss and expense prepared. This necessitated a knowledge of Contract and Law.

## **QUANTITIES USED**

The quantities used for the tasks described in iii) and iv) have to satisfy the Client's requirements and therefore were usually based on the current SMM. The quantities used for internal cost control and described in i) and ii) were at the surveyor's discretion but they usually followed SMM guidelines approximately with supplementary calculations to convert totals, including waste adjustments, into the target or BQ quantities for performance comparisons. Any re-measurement was undertaken on site and in accordance with the RICS SMM, the completed construction was measured to give the quantities. The materials invoices and labour return sheets were used to build up the gross cost of the construction under consideration. This meant that there was a difference between the measured quantities and the quantities of materials used.

# **INFORMATION**

Information received and generated by the Surveying Department of Lovell Midland Ltd:

| Received  | - | the tender documents<br>priced quantities<br>(estimate) |   | drawings<br>BQ/specification/design brief<br>quantities measured (by QS)<br>materials cost<br>labour cost<br>unit rates<br>wastage assessment |
|-----------|---|---------------------------------------------------------|---|-----------------------------------------------------------------------------------------------------------------------------------------------|
|           |   |                                                         | • | sub-contract quotes                                                                                                                           |
|           |   |                                                         | - | preliminary prices                                                                                                                            |
|           |   |                                                         | - | margin                                                                                                                                        |
|           | - | materials                                               | - | delivery tickets                                                                                                                              |
|           |   |                                                         | - | invoices                                                                                                                                      |
|           | - | labour                                                  | - | weekly return sheets                                                                                                                          |
|           | - | sub-contracts                                           | - | interim valuations                                                                                                                            |
|           | - | notification of variations                              |   |                                                                                                                                               |
| ,         |   | from site agent                                         |   |                                                                                                                                               |
| Generated | - | cash flow                                               | - | interim valuations for Client                                                                                                                 |
|           |   |                                                         | - | progress report for higher                                                                                                                    |
|           |   |                                                         |   | management                                                                                                                                    |
|           |   |                                                         | - | cost check actual spending                                                                                                                    |
|           |   |                                                         |   | against target                                                                                                                                |
|           | • | variations                                              | - | quantities                                                                                                                                    |
|           |   |                                                         | - | prices                                                                                                                                        |
|           | • | final account                                           | - | quantities                                                                                                                                    |
|           |   |                                                         | - | prices                                                                                                                                        |

#### THE SITE MANAGEMENT

# **GENERALLY**

Lovell Midland Ltd employed several levels of site management staff including:

 trade foreman based on site and responsible for particular types (trades) of construction;

- site agents based on one or more sites (depending on size and complexity of project) but liaising closely with the contractors manager and the purchaser, surveyor and planner appointed to the project;
- contracts managers based in the Aylesbury office and responsible for the overall performance of all projects.

Discussion were held with Mr James Lyle, one of two contract managers employed by Lovell Midland Ltd and it appeared that the role of site agent best filled the requirements of the research regarding the use of date. The role of contracts manager was deemed to be included in the higher management function, not directly involved with the quantity data. The role of the site agent described here resulted from the discussions with Mr Lyle.

The main tasks of the site agent were to allocate and control the resources on site. This included deciding on what labour was available and who was best suited to the task in hand, where to obtain labour if directly employed personnel were not available, eg sub-contracting, what plant was needed to carry out the works and when to bring it onto site (in conjunction with the planning department), and the method of working and supervising the works generally. The site agent needed to be able to understand and comment upon the practicality of the design and to be able to carry out the tasks required of him. These included a thorough understanding of the effect the contractor's method of working had on the quantities of materials used. Quite a large proportion of materials incorporated into the building were ordered from quantities prepared by the site agent. These quantities reflected the actual quantities of materials used (including wastage, etc.) and, as such, were unrelated to the quantities used by the estimator, in that they were derived from a different source (the site).

#### **INFORMATION**

Information received and generated by the site management of Lovell Midland Ltd:

| Received | - | the tender documents | - | drawings                      |
|----------|---|----------------------|---|-------------------------------|
|          |   |                      | - | BQ/specification/design brief |
|          | • | programme            |   |                               |
|          | - | labour rates         |   |                               |
|          | • | sub-contractors      | - | trade                         |
|          |   |                      | - | programme                     |
|          | - | materials suppliers  |   |                               |

| Generated - | materials | -   | quantities measured for purchaser<br>and surveyor                  |
|-------------|-----------|-----|--------------------------------------------------------------------|
|             |           | • - | usage recorded via delivery                                        |
|             |           |     | tickets, invoices, etc.                                            |
|             |           | -   | variations noted for purchaser and surveyor                        |
| •           | labour    | -   | allocated in accordance with programme                             |
|             |           | -   | usage recorded on time sheets and<br>through sub-contract invoices |
|             |           | -   | variations noted for purchaser<br>and surveyor                     |
| -           | plant     | -   | requirement allocated in<br>accordance with programme              |
|             |           | -   | usage recorded via hire charges,<br>time sheets, etc.              |

# **PROGRAMMING AND PLANNING**

# GENERALLY

There were two planners employed by Lovell Midland Ltd, but discussions were held with one only, Mr Thomas Coyle, who described the function of planning and programming.

Once the tender had been accepted, the works were programmed to be completed within the contract period, including the allocation of the resources of labour and plant. It was at this stage that the total amount of resources required on site, and at which point in the construction of the works, was assessed. The purchasing department had already allocated the materials and sub-contract resources and this information was incorporated into the programme. The planning department also consulted with the site management when preparing the programme, particularly where the allocation of plant resources was concerned.

# **SCHEDULING**

The task of programming involved the scheduling of the resources measured in the Bill (either the client's Bill or one prepared for the purposes of estimating), into operations based on a time scale, eg manhours. Quantities were not used other than to judge the timespan of an operation and for scheduling the right amount of time to each operation. A programme was compiled based on a logic of operational sequence suitable for the proposed method of working.

## **INFORMATION**

Information received and generated by the Planning Department of Lovell Midland Ltd:

- Received the tender documents
- drawings
- BQ/specification/design brief
- quantities (if measured)
- sub-contractors programmes
- materials
- suppliers
- purchasers' schedule
- delivery dates

Generated - operational schedule

- contract programme

## CASE STUDY

#### **COMPANY B : LOVELL FARROW LTD**

## GENERALLY

Lovell Farrow Ltd was also part of the large national group of construction companies, Y J Lovell. This company was carrying out construction works in the south-east of England, particularly in the London area. Eight visits were made to the head office at Chiswick in London during November and December 1984.

#### **PROJECTS UNDERTAKEN**

Lovell Farrow Ltd's work was similar to that of Lovell Midland Ltd, comprising of large "one-off" projects, often for central or local government offices. Other clients included banks, insurance companies, large retail chains and commercial and industrial developers. Some housing projects were undertaken, sometimes on a speculative basis within a Partnership Housing Division which dealt with small projects, ie  $\pounds 10,000 - \pounds 1,000,000$ .

The tender enquiries were received in several forms, including Bills of Quantities, Specification and Drawing and Design and Construct documentation. Lovell Farrow Ltd have also undertaken management contracts whereby they controlled the project on behalf of the client, sub-letting most of the works to other contractors. However, approximately 80% of the work undertaken was based on Bills of Quantities contracts. Very little design and construct works were undertaken and only a limited amount of specification and drawing tender enquiries were received.

#### THE ESTIMATOR

#### GENERALLY

Lovell Farrow Ltd employed nine estimating staff comprising of a chief estimator, three senior estimators, two estimators and three trainees. The chief estimator, Mr Michael Summers, was the main contributor to the research discussion with assistance from estimating staff for specific project examples.

The tender enquiry was received by the estimator in the first instance. If the tender was in the form of a specification or a design brief, the estimator may refer it to a private practice Quantity Surveyor for measurement and submission of Bills of Quantities. However, if the workload permitted, the quantities were measured inhouse, either by the estimator himself or by in-house Quantity Surveyors.

The estimators in the small works division measured their own quantities for the specification and drawing contract tenders. In fact, this was the most common form of tender enquiry received by this department. The quantities for the other tenders without quantities were measured by quantity surveyors (both in- and outhouse).

No specific instructions were given to the Quantity Surveyors (either in- or outhouse) by the estimators on the method of preparing the quantities. Nor was any information supplied to the QS's about the use to which the quantities were to be put or the estimators requirements for successfully performing the task of estimating. Some feedback was given retrospectively, but this tended to take the form of criticism for inaccurate measurement.

# TRADES USING MEASURED QUANTITY DATA

The work was priced either by the estimator or by sub-contract quotation. The trades priced can be split as follows:

## **Priced by Estimator**

| ii) ( | Concrete |
|-------|----------|
|       |          |

- iii) Brickwork
- iv) Woodwork
- v) Drainage

#### Sub-contract quotes

- i) Roofing
- ii) Plumbing
- iii) Tarmacadam
- iv) Steelwork
- v) Landscaping
- vi) M&E services (if not nominated)
- vii) Cladding
- viii) Finishes

The sub-contracted trades were priced by means of a tender enquiry which included the drawings and the relevant quantities (usually a section from the BQ). In the case of tender enquiries, other than those based on BQs, a quantity surveyor prepared quantities for pricing for both sub-contractors and the estimator. These quantities are based on the current SMM and therefore were a record of items which make up the finished building. There were variations from the SMM and these occurred as a result of the cost implications of the items being measured. Items of little or no cost were ignored and items of significant cost were measured in more detail than the minimum required by the SMM. This was done to aid the pricing of the quantities. Speed in pricing was thought to be as important as accuracy for Lovell Farrow Ltd's estimators and consequently they required the quantities to have more emphasis on cost significance than the SMM.

#### **PRICING QUANTITIES**

When pricing the quantities not subject to sub-contract quotes, the estimator used current standard rates for the common items in each trade, eg reduced level excavation, concrete beds, common brickwork, skirtings, etc. More contract specific items may be priced on a pro-rata basis from the standard rates or the prices built up from the material, labour and plant to be used. This method of pricing often made use of standard labour and plant constants which were amended by the estimator with knowledge of the project being priced. The material cost was obtained from price lists held in the office or by telephone enquiries to suppliers or manufacturers.

When all the measured items were priced, consideration was given to the preliminary items. These items related to the form of contract to be used and the contractors' requirements for accommodation, temporary works etc. This section of the tender also had considerable bearing on the contractor's method of working. The method of pricing the preliminaries at this stage took the form of a percentage addition to the lump sum established for the measured items although some of the preliminary items were priced individually, eg site huts. These items were detailed in the preliminary section of a BQ, but the main considerations when assessing the percentage addition were the type of site and the practicality of the design. Often the site agent or contracts manager will advise the estimator on the significance of the preliminary items.

A percentage addition was also made to cover overheads and profit; this was known as the margin. The figure added was an assessment which reflected the opinion of the estimator as to the current market. It also reflected the desire of the contractor to win the tender. The prices submitted by the estimator for tender became the target prices for the various departments which handled the contract if the tender was successful.

# INFORMATION

Information received and generated by the estimator:

| Received -  | the tender documents | - drawings                      |
|-------------|----------------------|---------------------------------|
|             |                      | - BQ/specification/design brief |
|             |                      | - quantities measured (by QS)   |
| Generated - | priced quantities    | - material costs                |
|             | (estimate)           | - labour costs                  |
|             |                      | - unit rates                    |
|             |                      | - wastage assessment            |
|             |                      | - sub-contract quotes           |
|             |                      | - preliminary prices            |

- margin

#### THE PURCHASER

## GENERALLY

Five purchasers were employed by Lovell Farrow Ltd. One chief chief purchaser, three purchasers and a trainee. The chief purchaser, Mr David Taylor, was the main contributor to the research.

The purchaser was responsible for ordering materials for the project. It was the policy within Lovell Farrow Ltd to consider sub-contracts as a commodity, and therefore bought, in the same way as materials by the purchasing department. The quantities used for ordering were based on the BQ quantities with an allowance for wastage, bulking factors and rough conversions into the purchasing units made, where appropriate.

#### **PURCHASING SCHEDULES**

The first task of the buying department was to schedule out the materials from the measured quantities. This involved splitting the material content of the BQ items onto a schedule. It was at this stage that quantity adjustments were made to take into account the differences between the BQ quantities and the actual purchasing units and quantities required for the completion of the contract. This was followed by placing the open orders and negotiating prices for the supply of other materials. The purchasing department aimed to buy the best product for the cheapest price, not always the cheapest product on the market.

The purchaser, as an expert on market prices, advised the company surveyors on The material cost of variations. This knowledge of costing was also used to influence the design solution by compiling cost comparisons of various materials for variations to a contract or for contractor designed items.

The purchasing department of Lovell Farrow Ltd did not measure or take-off any quantities, but used the BQ quantities, and any quantities measured on site by the site agent or the surveyor, for ordering materials. Open order quantities were revised as the work proceeded and the records were updated in the same way. Quantities were monitored and recorded but not altered or initiated by the purchasing department.

## **PLACING ORDERS**

No allowance was made to the BQ quantities for bulk order items which were ordered on "open orders" through regular suppliers. These items were large in quantity and were used for the project throughout the contract period. These materials, once placed on an open order by the purchasing department, were called for by the site agent, as they were required, directly from the supplier.

Other orders were placed by the buying department in accordance with the programmed delivery dates. Any incidental materials were requisitioned by the site through the buying department, eg timber for formwork, and were taken from stock or ordered from builders merchants. Very little materials were found to be kept in stock and ordering from suppliers for each contract was the favoured method of procuring the materials for the contract.

#### INFORMATION

Information received and generated by the Purchasing Department of Lovell Farrow Ltd:

- Received the tender documents
- drawings
- BQ/spec/design brief
- quantities if measured
- priced quantities
  (estimate)
- material costs
- labour costs
- unit rates
- wastage assessment

- sub-contract quotes
- preliminary prices
- margin

Generated - materials schedule

- bulk items
- other large items
- standard items
- special/one-offs
- alternative quotations
- delivery dates

#### THE SURVEYOR

## GENERALLY

The surveying department at Lovell Farrow Ltd comprised chief surveyor, two senior surveyors, one surveyor and one trainee. Again, it was the chief surveyor, Mr Richard Armitage, who provided most research information regarding the surveying function with reference to other members as required.

The surveying department monitored the performance and profitability of the project along with defining target costs for the site management to work within. The project surveyor was also responsible for controlling the post contract cash flow throughout the contract period. These were achieved as follows:

- i) performance and profitability were assessed by comparing the actual costs incurred with those allowed for in the tender by the estimator. This involved regular monitoring of labour sheets and materials invoices. Cash flow was monitored at the same time by comparing these figures with the amounts paid to the contractor in month valuations.
- target costs were set for the site management based on the allowances made for labour in the estimate less a sufficient margin for profit and overheads. The target cost was usually expressed as a lump sum which was given to the site management for either particular trades or operations.
- iii) payment of agreed amounts by the client was ensured by the submission of regular interim valuations of the work completed etc. by the surveyor.

Variations were measured and valued and the final account negotiated by the surveyor with the client's representative.

iv) the regular progress of the works was monitored by the surveyor in consultation with the site management. The surveyor prepared and submitted contractual claims for loss and expense to the client where the works had been disrupted and progress hindered or altered, as allowed for under the contract.

## **QUANTITIES USED**

The quantities used for these functions were usually based on the RICS SMM as they had to satisfy the client's requirements. However, on projects other than those tendered on BQs, quantities could be prepared in other ways. Lovell Farrow Ltd based most of their measurement on the SMM for convenience, but they felt that the SMM did not lend itself to post contract management within contracting organizations. Data measured in this way involved a considerable amount of reworking to convert the gross quantities of resources used into the net quantities required by the SMM to provide unit rates for valuation and final account purposes.

#### INFORMATION

Information received and generated by the Surveying Department of Lovell Farrow Ltd:

| Received | -          | the tender documents | - | drawings                 |
|----------|------------|----------------------|---|--------------------------|
|          |            | •                    | - | BQ/spec/design brief     |
|          |            |                      | - | quantities (if measured) |
|          | -          | priced quantities    | - | material costs           |
|          |            | (estimate)           | - | labour costs             |
|          |            |                      | - | unit rates               |
|          |            |                      | - | wastage assessment       |
|          |            |                      | - | preliminary prices       |
|          |            |                      | - | sub-contract quotes      |
|          |            |                      | - | margin                   |
|          | -          | - materials          | - | delivery tickets         |
|          |            |                      | • | invoices                 |
|          | <b>-</b> ' | labour               | - | weekly return sheets     |
|          | -          | sub-contracts        | - | interim claims           |
|          |            |                      | - | final accounts           |

notification of variations from site management

| Generated - | cash flow     | - | interim claims for client          |
|-------------|---------------|---|------------------------------------|
|             |               | - | progress report for higher         |
|             |               |   | management                         |
|             |               | - | cost check actual spending against |
|             |               |   | target                             |
| -           | variations    | - | quantities                         |
|             |               | - | prices                             |
| •           | final account | - | prices                             |

## THE SITE MANAGEMENT

#### GENERALLY

The function of site management was divided into levels, with working trade foremen based on site and site managers responsible for the construction works on one or more sites (depending on the size and complexity of the work). The site managers reported to the higher management team directly in conjunction with the purchaser, planner and surveyor allocated to the particular project. One site manager, Mr Ian Green, was interviewed and provided the information for the research.

The site manager allocated the plant and labour resources needed for the contract. This also included measuring the quantities of materials for drainage, fencing and temporary works when first coming onto site. Other materials measured as the works proceeded included formwork, rainwater goods, incidentals and sundries. The quantities measured are the gross quantities of the materials required to undertake the works. These quantities are passed to the purchaser for ordering. Labour resources are allocated and the surveyor's target costs are converted into manhours to provide a total performance time for the works. This time is checked with the programmed time available. Any major discrepancies would be brought to the attention of the surveyor who may provide revised costs. In severe cases, higher management may be consulted, particularly if a loss situation is likely to occur.

Plant resources were also allocated by the site, often similar target costs were provided by the surveyor, particularly if large quantities of plant were needed.

The site management also measured any discrepancies in the material quantities between the BQ and the drawings. These discrepancies were notified to the surveyor. Any shortfall in the quantities ordered by the purchaser was also measured and the purchaser notified.

## **INFORMATION**

Information received and generated by the site management of Lovell Farrow Ltd:

| Received  | - | the tender documents | • | drawings                           |
|-----------|---|----------------------|---|------------------------------------|
|           |   |                      | - | BQ/spec/design brief               |
|           | • | programme            |   |                                    |
|           | • | labour rates         |   |                                    |
|           | • | plant rates          |   |                                    |
|           | - | sub-contracts        | - | trade                              |
|           |   |                      | - | programme                          |
|           | • | material suppliers   |   |                                    |
|           |   |                      |   |                                    |
| Generated | • | materials            | - | quantities for purchaser and       |
|           |   |                      |   | surveyor                           |
| •         |   |                      | - | usage recorded                     |
|           |   |                      | • | variations noted for purchaser and |
|           |   |                      |   | surveyor                           |
|           | • | labour               | - | allocated in accordance with the   |
|           |   |                      |   | programme                          |
|           |   |                      | • | usage recorded                     |
|           |   |                      | - | variations noted for the surveyor  |
|           | - | plant                | - | allocated in accordance with the   |
|           |   |                      |   | programme                          |
|           |   |                      | - | usage recorded                     |

## **PROGRAMMING AND PLANNING**

## GENERALLY

Three planners and one trainee were employed by Lovell Farrow Ltd. Mr David Evans was the planner who was interviewed and observed.

The programme for the works was prepared as the purchasing department was scheduling out the material resources. The planner scheduled the BQ into timebased operations based on the quantities of materials to be fixed and the time needed to fix them. The allocation of time to the works was undertaken with advice sought from the site management. The data in the BQ was converted into manhours or mandays and presented in the form of a bar chart or critical path/network analysis. The delivery dates for materials were set in consultation with the purchaser and the site management and are incorporated into the programme.

# **INFORMATION**

Information received and generated by the Planning Department of Lovell Farrow Ltd:

Received - the tender documents

- drawings
- BQ/spec/design brief
- quantities (if measured)
- sub-contractors programmes (or contract period)
- materials

- suppliers
- purchaser's schedules
- delivery dates
- Generated operational schedule
  - programme

#### **CASE STUDIES**

## **COMPANY C : WM WALKERDINE LTD**

#### GENERALLY

Wm Walkerdine Ltd was a small to medium sized independent family company. The area in which work was undertaken covered the East Midlands and Derbyshire in particular. However, work was tendered for in Yorkshire, Wales, West Midlands and Cheshire. The company was based in Derby and a total of twentytwo visits were made of which fifteen formed the basis of this case study. The remainder formed the basis of the development of the draft set of measurement rules.

#### **PROJECTS UNDERTAKEN**

Work upto a value of £2M was undertaken. These projects could be as small as £5K or less. The work comprised new and refurbishment projects along with speculative house and office building. Wm Walkerdine Ltd did not have the facilities to undertake major design and design for construct projects, but they did undertake specification and drawing contracts. Their workload was split roughly 50-50 BQ to specification and drawing tender enquiries.

#### **THE ESTIMATOR**

## **GENERALLY**

Six estimators were employed by Wm Walkerdine Ltd comprising one chief estimator, two senior estimators, one estimator and two trainees. Mr John Grundy, senior estimator, was the main contributor to both the case study and the development of the first draft of the measurement rules.

The tender enquiries were received by the estimator in the first instance. Although a small proportion of the specification and drawing tenders (usually those involving large amounts of measurement) were sent to a private practice quantity surveyor for the preparation of a BQ, most of the measurement was done by the estimator for this type of tender.

The measurement of quantities was carried out first and a "Bill" prepared; this document was then priced as a separate operation. There was then no difference in the pricing methods between a BQ tender and a spec and drawing tender.

## **TRADES MEASURED**

The measurement of quantities by the estimator was carried out roughly in accordance with the current RICS SMM in so much that the finished quantities were measured rather than the actual quantities of materials needed. The estimators said that this was because the actual quantities to be used were uncertain until the work commenced. At tender stage only the quantities of the finished building were definite so these were measured and an assessment of wastage made to compensate for the actual quantities. It was suggested that more feedback from the site on the actual usage of materials and labour would be useful when assessing this wastage factor.

The data measured by the estimator was taken-off in trades, although the measurements were not abstracted out into a formal BQ but priced in take-off order. For simple jobs, whole trades may be measured together, eg all the brickwork. Larger, more complicated jobs involved measuring in function units, eg a door might include forming the opening, the frame, ironmongery, etc., all grouped together under the item of door. Conversely, the building could be split into convenient elements. The method of measurement for specification and drawing tender was greatly influenced by the format of the specification. The division of the works within the specification governed the grouping of measured data and subsequent pricing; this was due solely to the fact that the successful tenderer would be required to submit a priced specification to the client, therefore any data prepared by the estimator had ultimately to be presented in the specification format.

The measured data were split into those for pricing by the estimator and those relating to sub-contracts. It was interesting to note that the policy of this company was not to send any quantity information to sub-contractors where none was prepared by the client, only a drawing and description of the works. Therefore, for specification and drawing tenders only the works to be priced directly by the estimator were measured. These works were identified as follows:

#### Measured by estimator

# Excavation Brick/blockwork Concrete work Woodwork Drainage

#### Sub-contract quotes

Steelwork Special finishes, eg carpet Insitu finishes Tarmacadam Painting Alterations External works Asphalt work Glazing Plumbing Fencing Cladding Demolition

## **PRICING QUANTITIES**

Most items priced by the estimator were priced from first principles, ie built up from plant, labour and material costs. However, familiarity with more commonly occurring items, etc brickwork, excavation, led to unit rates being adopted by each estimator. In each case, the project was considered to establish any major differences with previous projects and an adjustment made to the unit rate where appropriate.

Sub-contract works were priced after enquiries had been made to various subcontract companies. No quantity information is sent with these enquiries, a lump sum quote is preferred by the estimator. Should the tender require unit rates, eg if it is a BQ tender, the estimator may require the sub-contractor to submit a schedule of rates when the priced BQ is requested by the client. If the sub-contract works are not complicated, however, the estimator may break down the sub-contract quote himself.

# **INFORMATION**

Information received and generated by the Estimating Department of Wm Walkerdine Ltd:

Received - the tender documents

drawings

• BQ/specification

Generated - measured quantities for specification & drawing tenders

- priced quantities
  (estimate)
- material costs
- labour costs
- plant costs
- unit rates
- wastage assessment
- sub-contract quotes
- preliminary prices
- margin

# THE PURCHASER/PLANNER GENERALLY

Wm Walkerdine Ltd employed a chief purchaser, a senior purchaser, two purchasers and two trainees. The chief purchaser, Mr Brian Davis and senior purchaser, Mr Edward Hunt, were the main contributors to the case study.

The purchasing department were notified as soon as a tender was accepted. The purchasers were concerned with the placing of orders for materials and domestic sub-contractors. They were also concerned with compiling the programme for the works. The two tasks ran more or less concurrently, however the first task was always the examination of the project to isolate any problem materials which may have delivery difficulties. Once these had been noted, the tasks of scheduling the estimate into purchasing units (whether materials or domestic sub-contracts), ordering the items and programming the works were not undertaken in a noticeably fixed order.

#### **PURCHASING SCHEDULES**

If the tender was based on a BQ, the purchaser drew up a materials schedule which was a list of materials contained in the BQ. The quantities were checked against the drawings and any large discrepancies between the BQ and the drawings were brought to the attention of the surveyor. The materials schedule was a list of total materials, so the individual Bill totals are aggregated. The BQ information was then split into items to be purchased and items to be actioned by site. The items to be purchased were further divided into bulk items (large quantity items used regularly and purchased on an open order) and items needing more detailed quantitative information. Where necessary, each of these were split again if any material was on a long delivery period. This meant that the purchaser needed to take early action to have materials on site at the correct time.

Specification and drawing contracts were dealt with in the same way except that the quantities were entirely measured by the purchasing department for their own use. Again, any discrepancies between the specification and the drawings were brought to the attention of the surveyor.

#### **PLACING ORDERS**

The purchasing department were responsible for obtaining the materials and domestic sub-contracts at the most favourable rates possible. This meant that alternative quotations were sought from those used by the estimator. It was the purchaser's knowledge of market rates that enable the opportunity of obtaining more favourable quotations to be recognised quickly.

The information provided to sub-contractors was based on the information contained in the tender (now contract) documents. This meant that quantities were only used if they existed within those documents, no quantity data was provided otherwise.

## PLANNING

The planning task was undertaken at an early stage and advice usually sought from the site management. The first operation was to prepare a bar chart on which the building process was broken down into elements and operations represented by a time scale. The quantitative information available was used as a guide to the size of the project and the labour and plant resources needed. The purchaser incorporated the delivery dates and the site manager allocated the plant and directly employed labour. The eventual programme took the form of a bar chart and line of balance or a combination of both based on the critical path analysis. Weekly reports from the site were plotted against the proposed programme by the purchaser to indicate progress. This information was incorporated into a monthly progress report to higher management.

Occasionally the purchaser was involved in preparing the tender when the contract period formed part of the tender. This could occur when a client required the project to be completed quickly to obtain a fast return on an investment. In this case the contract period could form part of the tender and be an important consideration in the award of the contract.

## **INFORMATION**

Information received and generated by the Purchasing/Planning Department of Wm Walkerdine Ltd:

Received - the tender documents

- drawings
- BQ/specification

| - | the | estimator's | measured | quantities |
|---|-----|-------------|----------|------------|
|   |     |             |          |            |

- the priced quantities - п (estimate) - la

- material costs
- labour costs
- unit rates
- wastage assessment
- sub-contract quotes
- preliminary prices
- margin

Generated - materials schedules

- bulk items
- long delivery items
- other items
- alternative sub-contract quotes
- delivery dates
- operational/elemental breakdown of project
- programme
- regular progress reports

#### THE SURVEYOR

## GENERALLY

There were eight surveyors employed by Wm Walkerdine Ltd, one chief surveyor (also a director of the company), three senior surveyors, three surveyors and one trainee. Mr David Richards, senior surveyor and Mr Richard Smallman, surveyor, assisted with the case study research.

The surveyors of Wm Walkerdine Ltd saw their main task as monitoring and controlling the progress and profitability of the contract. To do this they used information given to them by the estimator, the purchaser and the site management. This information showed the surveyors the costs incurred for labour, plant and materials throughout the contract period and the amount of profit or loss being made. Target costs were set at the beginning of the contract period for the site and a detailed budgeted amount of expenditure available for plant and labour.

The cash flow of the project was controlled by the surveyors by submitting regular interim valuations to the client for payment. These valuations reflected the amount of work completed, the materials on site, any variations carried out to the works, fluctuations. It was important that these valuations were correct to ensure the contractor did not have large sums of money outstanding, particularly when subcontractors and suppliers request payment regularly.

# **QUANTITIES USED**

The claims for payment submitted to the client were presented in the same format as the contract documentation, ie where there was a BQ, then in BQ format. This meant some reworking of the data received from site regarding variations was required before they were presented to the client's representatives. This was because data from the site represented the gross quantities of labour, plant and materials used and the client required data to be expressed as the net quantities of materials contained in the completed works.

The data received from the estimator was abstracted to form the target costs for labour. These costs were expressed as the amount of expenditure on labour per week per construction operation and enabled the site to employ accordingly. Similarly with plant. Therefore the estimator's priced breakdown was reorganised into an operational sequence that followed the programmed sequence of the works. The surveyor combined the estimate and the programme when compiling the targets.

To check the profitability, the quantities of manhours actually used, combined with the total cost of the plant and the quantities of materials (expressed in their buying units) were aggregated and checked against the targets and the estimator's costings. Again, this required some reworking of the information from labour sheets, delivery tickets and invoices etc. to express these items as net quantities.

## **INFORMATION**

Information received and generated by the Surveying Department of Wm Walkerdine Ltd:

| Received | - | the tender documents | - | drawings  |
|----------|---|----------------------|---|-----------|
|          |   |                      | - | BQ/specif |

- the estimator's quantities
- priced quantities (estimate)
- ification
- material costs
- labour costs
- unit rates
- wastage assessment
- preliminary prices

|           |   |                                  | ٠  | margin                                |
|-----------|---|----------------------------------|----|---------------------------------------|
|           | - | materials                        | •  | delivery tickets                      |
|           |   |                                  | -  | invoices                              |
|           | - | labour                           | -  | weekly return sheets                  |
|           | - | sub-contractors                  | •  | labour return sheets                  |
|           |   |                                  | -  | interim valuations                    |
|           |   |                                  | •  | final accounts                        |
|           | - | notification of variations/claim | 15 |                                       |
| Generated | - | cash flow                        | -  | interim valuations                    |
|           |   |                                  | •  | profitability reports                 |
|           |   |                                  | -  | cost checks of actual against targets |
|           | • | variations                       | -  | quantities                            |
|           |   |                                  | -  | prices                                |
|           | - | final account                    | ₽. | quantities                            |
|           |   |                                  | _  | ntices                                |

## THE SITE MANAGER

## GENERALLY

The site management function at Wm Walkerdine Ltd was undertaken by a senior contracts manager (also a company director), two contracts managers, six site agents and eight trade foremen. The individual site management function was undertaken by all these personnel acting as a team, but the site agent was the person responsible for the day to day management of the site and Mr Jeffrey Brookes and Mr David Banks, site agents, were the main contributors to the case study research.

The site manager was involved with the tender by advising the estimator on site difficulties and the practicality of the works, the plant needed, the contract period required, resources, etc. Once the tender was accepted the site manager then became involved with the programming by setting delivery dates, allocating domestic sub-contractor's programmes, breaking the building process down into elements and operations.

The site work was based on the drawings and any specifications of material and workmanship standards. The BQ, although received on site, was not used at all as variations to the contract tended to render the document inaccurate. Quantities of materials called for by the site either through the purchasing department or directly from the material suppliers on an open order, were not formally measured and documented. The quantities were an assessment of the amount of material required to undertake a particular element or operation. The assessment includes a wastage factor and as such were gross quantities.

# **INFORMATION**

Information received and generated by the site management function of Wm Walkerdine Ltd:

| Received  | - | the tender documents | - | drawings                          |  |  |
|-----------|---|----------------------|---|-----------------------------------|--|--|
|           |   |                      | - | BQ/specification                  |  |  |
|           | - | the target costs     | - | labour and plant from the         |  |  |
| surveyor  |   |                      |   |                                   |  |  |
|           |   |                      | • | materials from the purchaser      |  |  |
|           | - | the programme        |   |                                   |  |  |
|           | - | sub-contracts        | - | trade                             |  |  |
|           |   |                      | - | programme                         |  |  |
|           | - | materials            | - | suppliers                         |  |  |
|           |   |                      | • | delivery dates                    |  |  |
|           |   |                      |   |                                   |  |  |
| Generated | - | materials            | • | quantities for purchaser &        |  |  |
|           |   |                      |   | surveyor                          |  |  |
|           |   |                      | - | usage recorded                    |  |  |
|           |   | •                    | - | variations noted for surveyor and |  |  |
|           |   |                      |   | client                            |  |  |
|           | - | labour               | - | allocated in accordance with the  |  |  |
|           |   |                      |   | programme                         |  |  |
|           |   |                      | - | usage recorded                    |  |  |
|           |   |                      | - | variations noted for surveyor and |  |  |
|           |   |                      |   | client                            |  |  |
|           | - | plant                | • | allocated in accordance with the  |  |  |
|           |   | •                    |   | programme                         |  |  |
|           |   |                      | • | usage recorded                    |  |  |
|           |   |                      |   |                                   |  |  |

APPENDIX D

## INTERVIEWS WITH EXPERTS

#### APPENDIX D

:-

#### INTERVIEWS WITH EXPERTS

#### Contents

D.1 Introduction Page 2 -D.2 Methodology Page 2 -Harold Hussey Page 3 D.3 -D.4 John Walkerdine Page 6 -David Potter Page D.5 -9 - Michael Butler D.6 Page 13 Edward Skoyles D.7 Page 17 \_ Iris Addison Page 19 D.8 -D.9 Alan Stevens Page 20 -D.10 - Peter Brandon Page 21 D.11 - Conclusions Page 22

#### **D.1 INTRODUCTION**

This appendix summarises the main points of the interviews held with experts within the industry. The first three interviews were undertaken during the same period as the case studies and were used to confirm the findings of the case studies by triangulation outside the participating contractors management personnel. The five remaining interviews were undertaken during and after the field trials.

The interviews, documented here, were undertaken with the following experts on the date/s shown :-

1. Mr Harold J Hussey ARICS (10-08-84);

2. Mr John Walkerdine PPCIOB (various - see below);

3. Mr David C Potter FCIOB FBIM (24-03-85/20-09-86);

4. Mr Michael J Butler MCIOB (18-09-86 & 04-11-86);

5. Mr Edward R Skoyles FRICS FCIOB (06-11-87);

6. Mrs Iris Addinson (10-02-88);

7. Mr Alan Stevens (10-02-88);

8. Professor Peter S Brandon MSc FRICS (16-08-88).

#### **D.2 Methodology**

The interviews were conducted in an informal fashion and, as they were undertaken at differing stages of the research, had no common format. The approach adopted was to discuss the work undertaken on Builders' Quantities to the date of the interview, requesting criticism and

suggestions for progress.

The analysis of the data collected during the interviews was qualitative, notes were made of the points that were considered relevant in that they referred to the use and measurement of resources within the construction industry. The contents of this Appendix are a summary of these field notes. Some of the comments received and documented here also formed part of the development of the measurement rules for Builders' Quantities and are also referred to in Appendix E.

#### D.3 Harold Hussey

The interview was undertaken on the evening of 10th August 1984 at his home in Brentford, London. From this it can be seen that the interview was an informal one. Mr Hussey was the first person interviewed and as such provided assistance with the methodology of research generally as well as information regarding the measurement of construction work.

The main points raised by Hussey were as follows :-

i) That problems existed with the used of measured data for a contractors management tool,

ii) That these problems were recognised in the 1920's by Sumner-Smith (quantity surveyor). Sumner-Smith was opposed to the RICS (Institute of Surveyors as it was then) Standard Method of Measurement for the preparation

of quantities as they (the RICS) advocated measurement for the purpose of tendering without due consideration of the requirements of the contracting organisations and the methods utilised for the production of buildings.

iii) The intention of the RICS SMM to prepare Bills of Quantities for tendering were clearly stated in the preface to the first edition 1922.

iv) The method of measuring advocated by the RICS SMM has been criticised by many other bodies and individuals and continues to be so in the same vein as Sumner-Smith. These include :-

Ministry of Public Works : Code of Measurement for Housing (1940)

British Research Establishment : Operational Bills (1960's)

v) The RICS were also unsure of the success of their method of measurement shown by its frequent revision (developing the seventh edition at the time of this interview). The Research and Information Group of the Quantity Surveying Committee of the RICS commissioned an examination of the (then) current situation wishing to initiate a completely "fresh look" at the purposes of measurement. The report of this examination was published entitled "Rationalisation of Measurement" the authors were DJO Ferry and LG Holes.

This report was reviewed in depth by Hussey (not published) and a copy of the review lodged with the work

files for Builders' Quantities. It was apparent from this review that the examination and subsequent report were undertaken with a view to the preparation and use of quantities for tendering and did not fully address the problems concerned with production.

vi) Hussey maintained that many materials could only be ordered in certain units and that these units should form the basis of measurement.

vii) Hussey further maintained that much more help would be given to the estimator and planner when assessing the labour gang requirements if the works were measured in appropriate sections. An example was cited as follows :-

Concrete work measured - per bay or floor for floor slabs;

- per floor for columns.

viii) Hussey had undertaken much work both during his employment at the BRE and individually on the development of a building language and consequently examined the description requirements of the RICS SMM. This work was not published by the BRE although internal papers were made available by Hussey. Again, this work was not directly related to the study of Builders' Quantities but was enlightening in that it highlighted many of the ambiguities in the language used by the construction industry to describe its output.

ix) Hussey recommended that Mr E Skoyles would be a useful further contact as well as pursuing the research through as many contracting organisations as possible.

#### **D.4 John Walkerdine PPCIOB**

John Walkerdine was managing director of Wm Walkerdine Ltd and a collaborator in the first research application to SERC. Walkerdine made his company available for the case studies and field testing and these are documented in Appendices B and E respectively.

John Walkerdine was interviewed on four occasions :-

- 10th September 1984;
- 6th March 1985;
- 24th July 1985; &
- 28th November 1985.

Only the first and last of these interviews were documented here, as the other two formed the higher management function input into the development of the measurement rules given in Appendix E. All the interviews were undertaken at the offices of Wm Walkerdine Ltd in Derby.

#### Interview : Monday 10th September 1984

In this interview Walkerdine outlined what he felt were the main problems caused by the use of Bills of Quantities prepared by the client. These problems were :-

i) The BQs described the completed work and required the

contractor to assess and cost the processes of production required to produce the item described.

ii) In most cases, the BQs made no attempt to allow the location of the work within the structure to be allowed for, as all like work was lumped together regardless of location.

iii) The uniformity and increasing standardisation of description encouraged the use of standard unit rates with little or no adjustment by all but the most conscientious estimating staff. This jeopardised the accuracy of the tender.

iv) The inaccuracies in BQs, both the measured items and items such as Provisional and Prime Cost sums, meant that the BQ had little relevance to the construction works.

v) The BQs were of little use to the post-contract management of the construction works and was not referred to once the appropriate data had been abstracted, transformed or regenerated, other than as a specification for the standards of workmanship and materials required.

Much of the above had already been outlined in the first SERC application (see Appendix A) by McCaffer, and so confirmed many of McCaffer's arguments.

Walkerdine felt that data could be measured and

presented in such a way that the problems outlined above could be substantially reduced or eliminated. He felt that the best way to achieve this would be through observation of the use of measured quantity data within contracting organisations.

#### Interview : 28th November 1985

This interview was undertaken as the first report and the application for the second grant were being prepared for submission to the SERC. Walkerdine was therefore being asked to comment on the work undertaken to the first draft of the measurement rules and the hypothetical factory extension project.

The main points raised during this interview were :-

i) The resource split was basically a sound method for the measurement of Builders' Quantities. It allowed the resources in a single item of work to be measured in a combination of units most appropriate to those resource requirements.

ii) The use of more than one unit of measurement within a piece of work gave the measurement rules great flexibility which enabled construction method to be taken into account.

iii) The split of the construction work into sections which reflected location and gave an idea of the scope of work undertaken at any one time would aid the postcontract management of a project. This allowed the

personnel involved to assess what quantity of labour, plant and materials were required where and when.

Walkerdine felt, however, that it would be difficult to require estimators to enter data on two or more sheets at a time. This was a major criticism not of the theory of the resource split but of the practicalities of achieving it.

The conclusion of this interview was that the work was progressing along the right lines but that an alternative method of writing down the initial quantity data.

Walkerdine was confident that the solution could be found and was prepared to provide further support for the research by collaborating in the second application to the SERC (see letter held in work files).

#### D.5 David Potter FCIOB FBIM

David Potter was, at the time of this research, initiating a working party on behalf of the Chartered Institute of Building to investigate the post-contract use of estimators data. This work was intended to supplement the existing Code of Estimating Practice, documenting procedures and recommendations for the transformation of BQ data into data suitable for the contractors production processes. The area for study for this working party was, therefore, very closely linked to that of the research for Builders' Quantities. Potter
was also keen to support the second SERC application (see letter dated 6th September 1985 in work files).

Both interviews were undertaken at the offices of Lovell Construction Services in Uxbridge.

#### Interview : 24th March 1985

It was clear from the interview that Potter had given the matter some thought and that he favoured radical change as opposed to adaptation of existing methods to suit. He felt that traditional resistance to change could be overcome with company wide policy changes and training.

The basic principles advocated by Potter were that vertical construction work should be measured by height and horizontal work by area. He wondered if, for example, some means could be developed that enabled brick walls to be measured just by the number and length of corners. It was the corners, he said, that most affected the cost of the wall.

Potter agreed with the principle of splitting the resources at measurement stage, stating that it would reduce much of the compensating work undertaken at postcontract stage. He further pointed out that it was normal for estimators to compile some sort of resource breakdown during the tender preparation anyway.

Potter read the case studies of Lovell Midland and

Lovell Farrow with interest and was happy with the findings. However, he pointed out that Lovell Farrow did not undertake work on a Management Contracting basis.

# Interview : 20th September 1986

This interview was undertaken during the early stages of the second research period. It resulted from Potters written support for the second grant application to SERC. By this time, the CIOB working party had been disbanded without reaching any conclusions due to a reorganization of the Institute's administrative structure.

The research findings had been documented and a report submitted to the SERC. This report was forwarded to Potter and formed the basis of the discussions for this second interview.

Potter confirmed the findings regarding the use of data by the various management functions stating that it matched up with his own experience. He found the use of this study to tabulate what data was used for given items of construction work by the various management functions interesting as he had not seen this attempted before.

The combined taking-off sheet that had been developed showing the resource split on a single page (following comments by Walkerdine), was thought by Potter to be sound in theory although probably too complicated for

the material resource. This complexity would, he maintained, detract form the ease of use the research should be aiming at.

The future progress of the work for Builders' Quantities was discussed. Potter felt that testing and development of the measurement rules was the correct way forward but suggested that the contracting organizations involved in this were different from those participating in the case studies. He felt that the study would become too company specific if "new blood" as it were, were not introduced.

Potter felt that the best method for the testing would be to require the management personnel to use the rules themselves. He qualified this however, by commenting that the current boom in construction work would make it difficult for time to be spared for this work.

When asked to comment on the incidence of transformation and regeneration of data that had been observed, Potter confirmed that these had been anticipated (but not documented) by the former CIOB working party. He added that this area of study would prove worth while and that the CIOB would be interested in the publication of any findings.

The general conclusion of the interview was that the research still had a long way to go and that the additional areas uncovered should be fully exposed and published.

## D.6 Michael Butler

Michael Butler was appointed to Chair the CIOB working party investigating the post-contract use of estimators data. He was also a director of Wates Special Works based in Croydon. Prior to the interviews, a copy of the first report for the SERC was sent to him to provide some insight into the Builders'Quantities project.

## Interview : Thursday 18th September 1986

This interview was conducted at the head quarters of the Chartered Institute of Building, Ascot. The first part of the day being taken up with the initial meeting of the working party investigating the post-contract use of estimators data.

At this meeting, the working party examined the brief given to them by the CIOB and defined the terms of reference for the work. It was decided that the working party would be examining the work undertaken by the management functions of contracting organisations during the period between signing the contract and commencing the site work. It was clear therefore, that there was a considerable common ground between the brief of th working party and the research required for the definition of Builders' Quantities.

Butler recognised this common ground and thought that the work undertaken for Builders' Quantities would be of

considerable interest to the working party.

Butler confirmed the following findings of the case studies :-

(i) The definition of the management tasks and functions as given in Chapter 5 Table 4. Butler acknowledged that the list given was similar to the organization of the management structure within Wates;

(ii)Butler confirmed that the measured quantities contained in Bills of Quantities prepared by the client were of little use in the production of buildings. He added that the management functions prepared any quantity data they required themselves from the working drawings and that the quantity surveyor (contractors) was responsible for monitoring the financial situation. This entailed matching the various sets of measured data ensuring that total budgets were not exceeded. This was often dealt with on a total trade or elemental sum rather that item to item basis. In complicated projects with many variations, this "financial matching" may involve the contract total only such was the difficulty in comparing the differing measured data.

(iii) Butler agreed with the findings of the Walkerdine interviews (see Appendix D section D.4) stating that the quantities required for the management of the differing resources could only be useful if shown broken down as advocated. He also confirmed that a single taking-off sheet would be necessary if the industry was to accept

any changes in data management.

(iv) Butler picked up a point made by Walkerdine in the first interview (10th September 1984) in which Walkerdine described the use of standardized descriptions and units rates. Butler stated that this was a continuing concern not only to his company but to the industry generally. This problem had given rise to the publication of the CIOB Code of Estimating Practice in 1966. The subsequent revision showed that it continued to be of concern to the industry generally and had given rise to the initiation of the working party investigating the post-contract use of estimators data.

Butler continued to stress that this was an important area to the construction industry. Improving the use and usefulness of measured data could only be achieved if the data was easily transferable between the management functions. For this reason, Butler felt that the study of the data flow undertaken for Builders' Quantities would be of interest to the working party. It was suggested that the findings of this study should be shown to Graham Spiers who was appointed as Author to the working party.

Butler indicated that he would be willing to provide support for the development of the measurement rules and suggested that he be contacted again once specific requirements were identified.

Interview : Tuesday 4th November 1986

This interview was conducted at the head offices of Wates Special Works in Croydon.

The specific requirements of the development of the measurement rules for Builders' Quantities were outlined by the researcher as follows :-

(i) for the estimating department of Wates to use the measurement rules for the preparation of tenders;

(ii) this would result in the Builders' Quantities being used for the post-contract management of any successful tenders by the appropriate management functions;

(iii) the use of the Builders' Quantities on live project would test the theory and allow development by incorporating the criticism of the management personnel; &

(iv) the researcher be involved in all of these activities to explain and assist as required.

Butler recognised that this would be the ideal method for testing the measurement rules but did not feel that it would be possible to tie up management personnel in this way. The company was extremely busy and needed to return tenders within days rather than weeks and that it would not therefore be possible for the estimators to learn and use an entirely new system.

Butler also pointed out that there was a practical difficulty in the participation of the researcher in firstly, the travelling distances involved and secondly, the confidential nature of the data used.

However, it was possible to provide a suitable project for the testing of the measurement rules by the researcher outwith the construction company. The management personnel would be able to provide critical appraisal of the measured data produced by the use of the measurement rules.

The project selected was a fairly simple steel framed office and technology block in Croydon. The contract was a standard one with Bills of Quantities and the work comprised the trades identified as using directly employed or labour only labour (except alterations). This made this project a suitable test vehicle for the measurement of these trades using Builders' Quantities. Butler made no further comment on the measurement rules at this interview.

# **D.7 Edward Skoyles**

The interview was undertaken at the headquarters of the Royal Institution of Chartered Surveyors, Great George Street, London on 6th November 1987. Contact had been made subsequent to the recommendation of Hussey. Skoyles led the BRE working party investigating operational Bills of Quantities during the 1960's. This work had

involved the examination of traditional trade Bills of Quantities and looked at the affect that location within the construction had on the use of resources.

Skoyles was pleased to see that Hussey had referred to Sumner-Smith. Skoyles had known Sumner-Smith personally and was familiar with his theories on the use of the RICS method of measurement and their inadequacies as management tools for contractors.

Skoyles supported the hypothesis for the work, stating that he had long held the belief that the management functions of contracting organizations could be better served by alternative measured data. Indeed his own work with the BRE some twenty years previously had been based on the theory that the incorporation of construction method into measurement practices would improve the usefulness of the measured data. This theory had underpinned the work on operational Bills of Quantities.

Skoyles maintained that the hypothesis for Builders' Quantities was further supported by the work undertaken by the BPF and the fact that they recommend the use of activity schedules rather than Bills of Quantities for the documentation of construction work. These activity schedules could, he said, be compiled in any manner deemed suitable by the contractor and provided much opportunity for contracting companies to compile data in a manner that best suited their organizational and management methods.

Skoyles felt that one important issue addressed by Builders' Quantities that had not been addressed within measurement rules before was the purchasing unit for the materials resource. He added that work had been undertaken into the packaging of materials by Michael Powel. Skoyles stated that he was sure the resource split was the right approach providing that the measurement process itself could be kept simple. He recognised that the management process of construction would be best served with data compiled and presented with the various resources detailed separately, thus enabling the full effect of the construction process to be accounted for.

In summary, Skoyles was in support of the research project and felt it was important that it be followed through. He had reservations about whether the industry would adopt radical change though, as he had already experienced the immobility of construction professionals when faced with radical changes.

Skoyles recommended that Mrs Iris Addison and Mr Alan Stevens, both of the BRE, might have useful information and should be contacted.

### D.8 Iris Addison

The interview was undertaken on 10th February 1988 at the Building Research Establishment, Garston, Hertfordshire. Mrs Addison was a mathematician who was

involved in the analysis of data generally. However, she had been involved with one project in particular (referred to by Skoyles) in the collection and analysis of data relating to the occurrence and frequency of preliminary items on site.

Addison did not feel however, that she could contribute anything to the study of Builders' Quantities as she had no experience of measuring construction work.

It was felt that the work undertaken by Addison would not contribute to the Builders' Quantities as they were to be project specific and the preliminary scope of the work would be apparent and not based on what might occur most frequently throughout the UK. The data collected by Addison had related to what contractors had or had not priced in Bills of Quantities not an examination of the resources required and the contracting methods involved.

## D.9 Alan Stevens

Mr Alan Stevens was interviewed at the BRE offices on the same day as Mrs Addison ie. 10th February 1988.

The work undertaken by Stevens examined productivity in housebuilding and culminated in the development of computer software for sampling activities and analysing productivity.

Stevens work was not relevant to the determination of quantities to be measured for Builders' Quantities for the following reasons :-

1) it related to housing building only;

2) it studied the labour resource only;

3) it collected productivity hours only and did not attempt to analyse construction methods; and

4) it did not recognise particular construction details only whether or not the work was productive.

It was felt however, that the work might be of use in the capture of cost data for subsequent use within Builders' Quantities as a manual method. The software produced, however, would require major amendments to allow the input and analysis of productivity based on construction detail. Stevens felt that this amendment would be so great as to require the development of new and more appropriate software.

The overall conclusion was however, that Stevens work was of little relevance to the work undertaken for Builders' Quantities.

## D.10 Professor Peter Brandon MSc FRICS

Peter Brandon was interviewed informally at the home of a mutual friend on the evening of 16th August 1988. The work at this stage was substantially complete and Brandon was asked for criticism of the philosophy and findings of the work.

Brandon agreed with the basic philosophy that existing

measured data gave little scope for use as a contractors management tool. He also supported, in principle, the splitting of resources at the measurement stage and liked the idea of a single taking-off sheet that enabled this to be undertaken.

Brandon felt that the principles of the measurement rules for Builders' Quantities would form a suitable "front end" to computerized measurement and estimating systems one such being RIPAC. He also thought that there was potential in the work for the development of computerized resource data management systems for medium/small contracting organizations who were unable to finance their own research and development work.

To conclude, Brandon was encouraging about the nature of the work undertaken, stating that it was an area of study that had been required for many years but one that had not be directly addressed. He felt that contracting organizations were adopting an ad-hoc approach to the preparation of measured data for the management of construction resources, especially the large companies who were developing sophisticated management systems.

# **D.11 Conclusion**

The main conclusions to be drawn from the interviews with industry experts were :-

1) That existing measured data from Bills of Quantities was not suitable for use as a contractors management

tool;

2) That the concept of Builders' Quantities had merit;

3) That measured data prepared in a format that allows the considerations of location, scope, operational sequence and contractors method on the individual resources rather than on their aggregated totals was a considerable step towards providing an effective contractors management tool; and

4) That there was potential for further development work especially in software packages for medium/small contracting organizations.

APPENDIX E

# FIELD TESTS : EVALUATION OF TESTED WORK

# APPENDIX B

# FIELD TESTS : EVALUATION OF TESTED WORK

: -

# Contents

E.1 Introduction Page 3 E.2 Scheduling System Page 3 E.3 Factory Extension Page 4 E.4 M.I.R.A Building Page 6 E.5 School Page 12 E.6 United Reform Church Page 15 E.7 Co-Op Store Page 17 E.8 Office Development Page 20

#### APPENDIX B

FIELD TESTS : EVALUATION OF TESTED WORK B.1 Introduction

As detailed in the methodology (Chapter Three 3.9), contracting personnel were asked to comment upon the quantity data produced during the field testing phase of the research. The measured data was left with the contracting personnel to allow them to study it in some depth, discussions were then held with the various personnel involved. The comments made during these discussion (which may not have taken place on the same day) formed a direct evaluation of the measurement rules as the contracting personnel participating were the personnel responsible for the management of the five actual test projects.

### **B.2 Scheduling System : April - July 1985**

The evaluation of the scheduling system was undertaken by an estimator and a higher manager and their comments were detailed below.

# Evaluation of Scheduling System : August/September '85

(i) By estimator : John Grundy

- the requirement of individual resources to be entered on several differing sheets at once was too time consuming;

#### (ii) By higher manager : John Walkerdine

- the material resource was dictating the method of measuring and costing, this was one of the problems with the existing system;
- the system was not flexible enough to reflect the contractors method of working or even the construction sequence. It would consequently be of little use to either planners or site managers;
- it was unreasonable and impractical to expect estimators to enter data on several sheets at once. The amount of cross referencing alone would increase the time required to prepare a tender.
- the method did allow the effect of location to be fully considered but this benefit was far outweighed by the disadvantages outlined above.

The scheduling system was therefore abandoned as too time consuming and not fulfilling any constructive purpose.

**E.3 Factory Extension : November 1985** 

This was a hypothetical project incorporated at the end of the study of the Contractors' Use of Data. This project was the first attempt to reflect the measurement process within the constraints of an average construction project. It was evaluated by the management personnel within Wm Walkerdine Ltd (the main collaborating contracting organization) and the comments

received were :-

# **Evaluation of Factory Project : December 1985**

(i) By estimator : John Grundy

- the taking-off sheet (vide Chapter 8.22) was cramped with insufficient space to adequately describe and account for the resources required.
- errors would arise as the system did not allow adequate annotation and breakdown of work.
- It was unnecessary to total labour and plant in order to add a margin. Indeed as the principle for Builders' Quantities was to separate the resources, it seemed illogical to then start to aggregate them again.
- the grouping of work as described in the rules still did not allow the flexibility that would be required for a successful system of Builders' Quantities. The items were too complex, incorporating description of technological features rather than resources. Less design description and more thought to incorporation of resources to achieve the design was required.

# (ii) By purchaser/planner : Brian Davis

- the cramped nature of the sheets and the necessity to use several to measure one item of work fragmented the material resource and made

it difficult to establish where the quantities had come from and consequently shed doubt on the reliability of the data.

- the disjointed nature of the measured document made it difficult to organize the programme without further and considerable evaluation of the works.
- (iii) By surveyor : Richard Smallman
  - the system did not facilitate the preparation of labour targets, even though the labour resource was measured separately. This was because the fragmentation of measured items due to a cramped measurement sheet made it difficult to relate the data to the operational sequence required for targeting.
  - it was unnecessary to aggregate labour and plant costs as they were used separately anyway

The measurement rules and the taking-off sheet were revised prior to the field testing on actual projects. These revisions were not included in the first report to SERC and formed part of the development work undertaken for the second SERC funded research period.

**E.4 M.I.R.A Building : July - December 1986** 

This project was supplied by Wm Moss Ltd, Loughborough. It was a new build project comprising steel frame, brick cladding to low level, steel cladding above. The site

sloped and the building comprised partial basement construction.

The majority of the amendments made to both the measurement rules and the taking-off sheet were made during this test project. Unlike the others where only a single test was made (due to time constraints) three tests were made on this project.

The reasons for the number of tests were as follows :-

i) as the first "real" test, the flaws in the system advocated in the first draft were more apparent.

ii) the offices of Wm Moss Ltd were close to the University and therefore most easily accessible.

iii) the main participant was Mr Graham Spiers MCIOB who was also involved with the CIOB working party on the post-contract use of estimators data. This involvement combined with the interest shown by other members of the working party and the researcher's attendance at the working party meetings.

**Evaluation of First Draft : August 1986** 

(i) By estimator : David Williams

- the arrangement of the take-off sheet made the costing process convoluted;
- there was insufficient space to document the works adequately, particularly the materials.
- the contract reference was buried in the

heading section of the sheet and should be more prominent.

- the concept of a "work piece" was difficult to define.
- the system would probably not involve additional time to use (once learnt) but neither would it save time.
- (ii) by purchaser : William Barnes
  - it was difficult to follow the measurement of the material resource as it often spread over several pages and not annotated properly.
  - the reliability of the material quantities was doubtful because it could not be easily checked.
  - the measurement units for the material resource were an improvement on the existing systems (BQ, Spec/Drawing etc)
  - time could be saved by the improvement in the measurement unit but this was cancelled out by the need to check the validity of the quantities.

(iii) by planner : Paul Willis

- the concept of work pieces was difficult to relate to construction sequence.
- the representation of location was useful enabling cross referencing to drawn data.

(iv) by higher manager : Graham Spiers

- the comments made by the other management personnel were reasonable.
- the amendment of the headings on the take-off sheet to read "Item Description" in lieu of "work piece item" may be helpful in overcoming some of the difficulties in visualizing the work in small operations or pieces.

The project surveyor was unavailable at the time of the evaluation due to illness.

### **Bvaluation of second draft : September/October 1986**

The second attempt at preparing measured data for the MIRA project was evaluated by the research assistant only. This draft was abandoned as more consideration should have been given to the contractors method of construction before the test was commenced. This was a problem that had existed in the first testing but had not been specifically identified until this time.

#### **Bvaluation of Third Draft : January 1987**

(i) by estimator : David Williams

- the additional detail given about the methods to be adopted aided the process substantially.
- that the method statement influenced the method of measurement was good.

- the process of booking down information was still lengthy and the sheet cramped.
- the accuracy of the cost data and its relevance to the project appeared to be better than with a traditional BQ but it was more difficult to compile as the format was unlike most historic data kept.
- the introduction of a conversion factor to the reflect waste for the material resource allowed a simpler calculation.
- it was estimated that using the system might add 10% to the preparation time as the use of unit rates was a quicker method of costing the work.
- This additional time might however, be offset by improved accuracy and by making it easier to allow the margin.

(ii) by purchaser : William Barnes

- the sheets used were still cramped and causing the documentation of the material resource to be disjointed.
- the use of a conversion factor to reflect wastage was not a good idea. It did not allow individual factors to be taken into account and it made the calculation of gross quantities more difficult. The incorporation of this factor again threw doubt onto the reliability of the estimators data.

 it was apparent however, that if the problems outlined could be overcome, that some time could be saved during the management process. This time was estimated as being approximately 12%.

(iii) by planner : Paul Willis

- the use of item description in lieu of work piece description did not help the identification of where and how the work measured fitted into the construction.
- clarification notes and definitions would improve the understanding of the measured data and its relationship to the construction work sequence.

(iv)by surveyor : Richard Davey

- the use of measurement units that reflect the procurement units of the labour resource would form a considerable time saving measure.
- it was estimated that approximately 25% could be saved as the task of transforming data from BQ format was onerous.
- the splitting up of the resources and the detail of the margin would facilitate cost control and the monitoring of profitability.

(v) by higher management : Graham Spiers

- the testing showed that improvements could be made however, more could be done.

- it was imperative that the definitions of work pieces were tightened up.
- the relationship between the construction method statement and the method of measurement could be improved too.

This concluded the evaluation of the measurement of the MIRA Building by Wm Moss Ltd and the management personnel employed therein.

### **E.5 School Extension : August & September 1986**

This project involved an extension to a primary school in Derby. The structure was single storey cavity brickwork with a flat roof including cloak & changing rooms and external paving and landscaping works. The contract was undertaken by Wm Walkerdine Ltd.

The project was measured by a junior estimator under the supervision of John Grundy and with the assistance of the research assistant.

# **Evaluation of Tested Work : October/November 1986**

- (i) by estimator : John Grundy
  - the consideration of individual resource requirements simplified the measurement process as all design were ultimately only achieved by the site labour force who were restricted in the number and type of operations they could undertake.

- initially, all work could be allocated to a particular skill or "trade", but within each of these trades the labours were limited to such simple operations as lifting, mixing, carrying, tying, placing, compacting, cutting, nailing by one or more operatives working together.
- the variances in design complexity could be attributed to one or more of the following :-
  - : lower tolerances;
  - : restrictions on accessibility; and
  - : greater protection required.
- all of these could be accommodated by increased care on the part of the labour force and that equated to additional time required.
- the definitions of the work pieces should be clear therefore to allow an adequate assessment of time.
- this assessment of time would then contribute to the compilation of the programme and the site management.
- the splitting of the resources as advocated by Builders' Quantities was an improvement on the use of repetitive unit rates as it allowed the full cost considerations of the particular project to be taken into account.
- the lay out of the taking-off sheet could be improved although no suggestions were made as to how.

## (ii) by purchaser/planner : Brian Davis

- the incorporation of dimension columns into the taking-off sheet was an improvement allowing the quantity data to be presented in a more organized fashion.
- the grouping of the sections of work within the measurement rules were more logical and cross-referencing was improved.
- the separation of the material resource did assist the purchasing function and could save in the order of 15% of the time taken to list, order and manage the materials resource.

(iii) by surveyor : Richard Smallman

- the rules themselves were tighter and easier to follow.
- the definitions and clarifications were a useful aid.
- the use of measurement units which reflected the method of procurement for the labour resource did seem to offer the potential for substantial savings in the amount of time taken to compile targets and the subsequent monitoring of profitability.

- the savings could be as high as 35 - 40%.

(iv) by higher manager : John Walkerdine

- felt the comments from other management personnel were valid.

- the progress made was substantial and the work held promise of use at a more senior level for executive decision making. More detail of resource requirement at an earlier stage would also streamline executive decisions regarding workload, when to tender, at what margin, long and short term planning and staffing requirements, financing to name some examples.

# **B.6 United Reform Church : January - March 1987**

The company collaborating on this project were substantially different from all the others as they were a small specialist company employing ten people and using several sub-contract trades. The company had no information management systems as such and allowed complete access to all cost data within the company. The company demonstrated great need for management systems and were an ideal example of the sort of company who might benefit most from the work undertaken for Builders' Quantities.

The project involved the renovation of the church and attached church hall at Melton Mowbray. The building was grade II listed three storey solid brick construction with a pitched, slated roof. The construction work involved the renewal of solid and suspended ground floors, the renewal of timber staircases, extensive treatment for the eradication of dry rot, replacement DPC, structural repairs to the roofing timbers and

repointing and silicone treatment externally.

#### Bvaluation of URC test : March - May 1987

- (i) by director & estimator : John Burgin
  - estimating using unit rates was much quicker and easier than assessing resource requirements mainly because the information was more readily available.
  - it was however quicker to set up and start a job because much of the work required in assessing resource requirements had been done.
  - the consideration of particular method and attempt to anticipate site problems was good too.
  - this made it easier to relate site work to the estimate and pass on experience gained.
  - the assessment of resource requirement at estimating stage would certainly affect the tendering strategies of the company as it would be easier to see what the company was potentially committed to. This was especially important for a small company.
  - the system offered potential time savings in the region of 60% for the management of projects.

(ii) by purchaser/planner : Dawn Adcock

- the receipt of a fairly comprehensive breakdown of resources definitely made the

assessment and ordering of materials and stock keeping easier.

- there was no doubt about the reliability of the data as the location was given making it easy to cross-check.
- the assignment of men to jobs was also easier as the commitments of new contracts were clearer earlier. (This was undertaken in conjunction with the site manager).

(iii) by surveyor/site manager : Duncan Keith

 it was easier to monitor the profitability of the labour resource as it was costed originally in the format that it was utilized on site.

### B.7 Co-Operative Store : May - July 1987

This contract was undertaken by Charles Gregory Ltd at Kibworth in Leicestershire. The project involved large scale extension of an existing building into a supermarket. It was a very complicated design in which the existing courtyard was incorporated into the shop floor with the former boundary walls becoming external walls to the supermarket.

The only management personnel involved with the evaluation were Colin Draycott, managing director and Frederick Weston, site manager. The other management

personnel were unavailable due to work load.

## **Evaluation of Co-Op Test : August & September 1987**

- (i) by higher manager : Colin Draycott
  - the measurement rules showed great flexibility to allow the documentation of such complex work in a simple fashion.
  - this simplicity would allow easier access to relevant data for the management functions.
  - estimators would probably prefer to use unit rates for the preparation of the estimate however as they can use rates from similar previous projects.
  - the estimate would probably be more accurate using Builders' Quantities as the effect of location and particular site requirements could be adequately considered.
  - the incorporation of a preliminary method statement to supplement the estimate would be invaluable to the monitoring of the works post-contract.
  - the separation of the resources would greatly aid the targeting and procurement of those resources.
  - Monitoring of profitability would be easier.
  - the additional work required at tender stage
     would be offset by significant savings during
     the post-contract management of the works.

These savings would certainly occur in the time taken to perform the tasks required to the extent of halving it.

- the cost of works on site may be reduced as the use of the material resource may be more efficient and the rates paid to the labour force more meaningful in that they reflect site conditions (as opposed to standard rates regardless of location or other factors).

(ii) by site manager : Frederick Weston

- the project had raised several difficulties
   which would have been anticipated using
   Builders' Quantities ie.
  - (a) the reference to location would have allowed better consideration of the sequence of trades;
  - (b) the requirement to provide a method statement would have enable the more efficient use of labour and plant targets as considerable deviation from the BQ took place.
- a document that listed work items in an assumed construction sequence showing the number of hours allowed would have been a useful management tool against which to progress the works.

#### **B.8** Office Development : October - December 1987

This project comprised two steel framed, three storey office and technology blocks. The works themselves were simple and the site open with free access.

The management personnel participating in the evaluation were Michael Butler, Director and Keith Naylor, estimator, the work load of the company at the time prevented the participation of other management personnel.

Evaluation of Office Test : December '87 - February '88

- (i) by estimator : Rodney Fisher
  - the measured data would be more time consuming to cost due to the incorporation of location and the lack of historic data.
    - the breakdown of resources and the consideration of location and construction method would result in a more accurate estimate.
  - the taking-off sheet was relatively simple and the lay-out facilitated sequential measurement of items within a work piece.

(ii) by higher manager : Michael Butler

- the simplicity of the project allowed the full potential of Builders' Quantities to be realised. The construction method could be

- fully expressed within the resource breakdown.
  the resource breakdown would facilitate their post-contract management especially the purchasing of materials and the procurement of the labour resource.
- the inclusion of waste breakdowns related to location would allow the purchaser to cross check the measured quantities without remeasuring. This may result in savings in time taken of up to 28%.
- the representation of measured data in a construction sequence should aid the planning function although the time saved for this would probably only be in the order of 5%.
- the surveying function would be the one that would benefit most from Builders' Quantities. The relationship between the site works and the tender would be very close making the monitoring of profit easier.
- The use of measurement units that represented the units of procurement for the labour resource would speed up the process of compiling labour targets.
- it would not be difficult to foresee savings in the time required for the surveying function of up to 50%. This would be saving of substantially non-productive time, releasing, the surveyors to undertake more productive tasks.

 regular usage of the system would speed up the management processes and savings in the time required would probably be made.
· · · . . · · . . .